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(54) Title: HIGH-AFFINITY NUCLEIC ACID LIGANDS OF CYTOKINES

(57) Abstract

Methods for identifying and preparing high-affinity nucleic acid ligands to cytokines and the ligands obtained thereby are disclosed.

HIGH AFFINITY NUCLEIC ACID LIGANDS OF CYTOKINES

FIELD OF THE INVENTION

Described herein are methods for identifying and preparing high-affinity nucleic

5   acid ligands to cytokines. The method utilized herein for identifying such nucleic acid

ligands is called SELEX, an acronym for Systematic Evolution of Ligands by Exponential

enrichment. This invention specifically includes methods for the identification of high

affinity nucleic acid ligands of the following cytokines: IFN-gamma, IL-4, IL-10, TNFα,

and RANTES.

10   Further disclosed are RNA ligands to IFN-gamma, IL-4, IL-10, and TNFα. Also

disclosed are DNA ligands to RANTES. Specific examples are provided of

oligonucleotides containing nucleotide derivatives chemically modified at the 2'-positions

of pyrimidines. The oligonucleotides of the present invention are useful as

pharmaceuticals or diagnostic agents.

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BACKGROUND OF THE INVENTION

Cytokines are a diverse group of small proteins that mediate cell

signaling/communication. They exert their biological functions through specific receptors

expressed on the surface of target cells.

20   Cytokines can be subdivided into several groups, including the

immune/hematopoietins, interferons, tumor necrosis factor (TNF)-related molecules, and

the chemokines. Representative immune/hematopoietins include erythropoietin (EPO),

granulocyte/macrophage colony-stimulating factor (GM-CSF), granulocyte

colony-stimulating factor (G-CSF), leukemia inhibition factor (LIF), oncostatin-M (OSM),

25   cilary neurotrophic factor (CNTF), growth hormone (GH), prolactin (PRL), interleukin

(IL)-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-9, IL-10, and IL-12. Representative interferons

(IFN) include IFNα, IFNβ , and IFN-gamma. Representative TNF family members

include TNF α, interferon (IFN) β , gp[39] (CD40-L), CD27-L, CD30-L, and nerve growth

factor (NGF). Representative chemokines include platelet factor (PF)4, platelet basic

30   protein (PBP), groα , MIG, ENA-78, macrophage inflammatory protein (MIP)1 α , MIP1β,

monocyte chemoattractant protein (MCP)-1, I-309, HC14, C10, Regulated on Activation,

Normal T-cell Expressed, and Secreted (RANTES), and IL-8.

IFN-gamma

IFN-gamma was first described 30 years ago as an antiviral agent (Wheelock, 1965). Since that time the protein has been shown to be a remarkably pleiotropic cytokine which plays important roles in modulating virtually all phases of immune and

5 inflammatory responses. The cDNAs for murine IFN-gamma (Gray and Goeddel, 1983) and human IFN-gamma (Gray and Goeddel, 1982) have been cloned, sequenced, and characterized.

IFN-gamma is a member of a family of proteins related by their ability to protect cells from viral infection. This family has been divided into three distinct classes based on

10 a variety of criteria, IFN-alpha (originally known as Type I IFN or Leukocyte IFN), IFN-beta (also originally known as Type I IFN or Fibroblast IFN) and IFN-gamma (originally known as Type II IFN or Immune IFN). IFN-gamma is unrelated to the Type I interferons at both the genetic and protein levels (Gray et al., 1982). The human and murine IFN-gamma proteins display a strict species specificity in their ability to bind to

15 and activate human and murine cells. This is due at least in part to their modest homologies at both the cDNA and amino acid levels (60% and 40% respectively).

IFN-gamma is produced by a unique set of stimuli and only by T lymphocytes and natural killer (NK) cells. The human and murine genes for IFN-gamma are 6 kb in size, and each contain four exons and three introns. These genes have been localized to human

20 chromosome 12 (12q24.1) and murine chromosome 10. Activation of the human gene leads to the transcription of a 1.2 kb mRNA that encodes a 166 amino acid polypeptide (Derynck et al., 1982). The human protein contains a 23 residue amino terminal hydrophobic signal sequence which gets proteolytically removed, giving rise to a mature 143 residue positively charged polypeptide with a predicted molecular mass of 17 kDa.

25 Variable post-translational enzymatic degradation of the positively charged carboxy terminus (Rinderknecht et al., 1984) is responsible for the charge heterogeneity of the fully mature molecule. Proteins with six different carboxy termini have been detected for both natural and recombinant forms of IFN-gamma. Two polypeptides self-associate to form a homodimer with an apparent molecular mass of 34 kDa (Scahill et al., 1983). The

30 homodimer is the biologically active form of the protein. Mature human IFN-gamma contains no cysteine residues, thus the homodimer is held together entirely by noncovalent

forces. This quaternary structure of the native protein explains its characteristic sensitivity to extremes of heat (protein denatured at temperatures above 56°), and pH (activity rapidly lost at pH values less than 4.0 and greater than 9.0) (Mulkerrin and Wetzel, 1989). The remarkable pleiotropic effects of IFN-gamma are mediated through binding to a single

5   type of IFN-gamma receptor. The structure and function of murine and human IFN-gamma receptors have been described (Schreiber *et al.*, 1992). These receptor proteins are expressed on nearly all cells (except erythrocytes), and platelets (Anderson *et al.*, 1982). The receptor binds ligand with high affinity (Kd = 10^{-9} - 10^{-10}M) and is expressed on most cells at modest levels (200 - 25,000 sites/cell). Upon IFN-gamma .

10   binding to the receptor at the cell surface, the intracellular domain of the receptor is phosphorylated at serine and threonine residues (Hershey *et al.*, 1990).

One of the major physiologic roles of IFN-gamma is as a regulator of immune response induction, specifically its ability to regulate expression of class I and II major histocompatibility (MHC) antigens on a variety of immunologically important cell types

15   (Trinchieri and Perussia, 1985) Functionally, IFN-gamma dependent upregulation of MHC gene expression is an important step in promoting antigen presentation during the inductive phase of immune responses and may play a role in antitumor activity of IFN-gamma (Buchmeier and Schreiber, 1985).

Another major physiologic role for IFN-gamma is its ability to activate human

20   macrophage cytotoxicity (Schreiber and Celada, 1985). Therefore, IFN-gamma is the primary cytokine responsible for inducing nonspecific cell-mediated mechanisms of host defense toward a variety of intracellular and extracellular parasites and neoplastic cells (Bancroft *et al.*, 1987). This activation is a result of several distinct functions of IFN-gamma. IFN-gamma has been shown to effect the differentiation of immature

25   myeloid precursors into mature monocytes (Adams and Hamilton, 1984). IFN-gamma promotes antigen presentation in macrophages, through the induction of MHC class II expression as described above, but also by increasing levels of several intracellular enzymes important for antigen processing (Allen and Unanue, 1987). Macrophage cell surface proteins such as ICAM-1 are upregulated by IFN-gamma, thus enhancing the

30   functional results of the macrophage-T cell interaction during antigen presentation

(Mantovani and Dejana, 1989). IFN-gamma activates the production of macrophage
derived cytocidal compounds such as reactive oxygen- and reactive nitrogen-intermediates
and tumor necrosis factor-a (TNF-a) (Ding *et al.*, 1988). IFN-gamma also reduces the
susceptibility of macrophage populations to microbial infections.(Bancroft *et al.*, 1989).

5   Animal models have been used to study the role of IFN-gamma in the clearance of
microbial pathogens. Neutralizing monoclonal antibodies to IFN-gamma were injected
into mice before infecting them with sublethal doses of various microbial pathogens.
These mice lost their ability to resolve the infection initiated with *Listeria monocytogenes*
(Buchmeier and Schreiber, 1985), *Toxoplasma gondii* (Suzuki *et al.*, 1988), or *Leishmania*
10   *major* (Green *et al.*, 1990).

        Besides these nonspecific cell mediated cytocidal activities, IFN-gamma also
enhances other macrophage immune response effector functions. IFN-gamma
up-regulates expression of Fc receptors on monocytes/macrophages (FcgRI), thus
enhancing the capacity of the macrophage for antibody dependent cell killing (Erbe *et al.*,
15   1990). IFN-gamma also promotes humoral immunity through enhancement of
complement activity. It does this in two ways, i) by promoting the synthesis of a variety
of complement proteins (ie., C2, C4, and Factor B) by macrophages and fibroblasts, and ii)
by regulating the expression of complement receptors on the mononuclear phagocyte
plasma membrane (Strunk *et al.*, 1985).

20   IFN-gamma also exerts its effects on other cells of the immune system. It
regulates immunoglobulin isotype switching on B cells (Snapper and Paul, 1987).
IFN-gamma plays a positive role in the generation of $CD8^+$ cytolytic T cells (CTLs)
(Landolfo *et al.*, 1985) and enhances NK cell activity. Recently, it has been unequivocally
established that $CD4^+$ T cells do not constitute a homogeneous class of cells. Indeed, a
25   paradigm of lymphokine biology and of the function of $CD4^+$ T cells has arisen, the
so-called Th1/Th2 paradigm (for a review see Paul and Seder, 1994). The T_{H1} clones,
through their production of IFN-gamma, are well suited to induce enhanced microbicidal
and antitumor activity in macrophages as detailed above (enhanced cellular immunity),
while the Th2 clones make products (IL-4, IL-5, IL-6, IL-10, IL-13) that are well adapted
30   to act in helping B cells develop into antibody-producing cells (enhanced humoral
immunity). The role played by IFN-gamma at this crucial nexus of T cell effector function

is fundamental to the success or failure of the immune response.

IFN-gamma plays a major role in promoting inflammatory responses both directly, and indirectly through its ability to enhance TNF-α production. During an inflammatory response, cells leave the circulation and migrate to the point of infection. During this

5   process they must first bind to and then extravasate through vascular endothelium. Both IFN-gamma and TNF-α can promote the expression of overlapping sets of cell adhesion molecules (ICAM-1, E-selectin, and others) that play an important role in this process (Pober et al., 1986; Thornhill et al., 1991). In fact, experiments have shown that these two cytokines exhibit synergistic effects in up-regulating cell adhesion molecules in vivo

10   (Munro et al., 1989). One can envision microbial infections in which the microorganism is already widespread at the time the immune response develops or in which the response does not quickly rid the host of the infectious agent. This results in continued T cell activation inducing both local inflammation and tissue damage with ensuing loss of normal function. Indeed, when the infectious agent is of little intrinsic pathogenicity, the

15   disease induced by the infection may largely reflect the consequences of such a response.

Excessive production of IFN-gamma may play a role in autoimmune disorders (for review see Paul and Seder, 1994 and Steinman, 1993). The mechanism for this may involve excessive tissue damage due to aberrant or enhanced expression of class I and class II MHC molecules or the role of an excessive T_{H1} cellular response. A role for

20   IFN-gamma and the tissue-damaging effects of immune responses mediated by T_{H1}-like cells has been suggested in autoimmune disorders such as rheumatoid arthritis (Feldmann, 1989), juvenile diabetes (Rapoport et al., 1993), myasthenia gravis (Gu et al., 1995), severe inflammatory bowel disease (Kuhn et al., 1993), and multiple sclerosis (Traugott, 1988).

25

IL-4

Interleukin-4 (IL-4) is a remarkably pleiotropic cytokine first identified in 1982 as a B cell growth factor (BCGF) (Howard et al., 1982). In that same year, IL-4 was identified as an IgG1 enhancing factor (Isakson et al., 1982). Because of the effect IL-4

30   has on B cells, it was first called BCGF-1, later termed BSF-1 (B-cell stimulatory factor-1), and in 1986 it was given the name IL-4. The cDNAs for murine IL-4 (Noma et

al., 1986; Lee *et al.*, 1986) and human IL-4 (Yokota *et al.*, 1986) have been cloned, sequenced, and characterized.

IL-4 can be regarded as the prototypic member of a family of immune recognition-induced lymphokines designated the "IL-4 family" (for a review see Paul,

5   1991). This family consists of IL-4, IL-5, IL-3, and granulocyte-macrophage colony-stimulating factor (GM-CSF). The properties shared by these proteins leads to this grouping and include, i) the linkage of the genes for the members of the family (van Leeuwen *et al.*, 1989), ii) the action of each member of the family as a hematopoietic growth factor in addition to any effects it may exert on lymphoid cells, iii) the receptors

10   for these proteins are all members of the hematopoietin family of receptors (Bazan, 1990a), and iv) coexpression of these factors by a subpopulation of cloned CD4$^+$ T cells (the so-called T$_{H2}$ cells) (Mosmann *et al.*, 1989) and by mast cells (Plaut *et al.*, 1989).

The remarkable pleiotropic effects of IL-4 are mediated through binding to cell surface receptors (IL-4R). The murine IL-4R (Mosely *et al.*, 1989; Harada *et al.*, 1990),

15   and the human IL-4R (Idzerda *et al.*, 1990; Galizzi *et al.*, 1990) have been cloned, sequenced, and characterized. IL-4R are present on a variety of hematopoietic (Park *et al.*, 1987) and nonhematopoietic cells (Lowenthal *et al.*, 1988). On both human and murine resting T and B cells, IL-4R are present in low numbers (<400) and are regulated by cytokines and other factors. The receptor binds IL-4 with high affinity (Kd = 10^{-10} M).

20   Now that most of the receptors for immunoregulatory and hematopoietic cytokines have been cloned, it is apparent that the majority of these receptors fall into a large family. This hematopoietic cytokine receptor superfamily includes receptors for IL-4, IL-2 (b and g chains), IL-7, IL-9, and IL-13 which modulate the lymphoid system; and receptors for erythropoietin, granulocyte-colony stimulating factor (G-CSF), GM-CSF, IL-3, and IL-5

25   which modulate the hemopoietic system. The superfamily also includes receptors for factors believed to normally function outside the immune and hematopoietic systems, including receptors for growth hormone (GH), prolactin, leukemia inhibitory factor (LIF), IL-6, IL-11, and ciliary neurotrophic factor (CNF) (for a review see Kishimoto *et al.*, 1994).

30   A general first step in the signaling processes of immune and hematopoietic cytokines may be ligand-induced dimerization of receptor components whose cytoplasmic

regions interact to initiate a downstream signaling cascade. The IL-4 receptor has a long
putative intracellular domain (553 amino acids in mouse, 569 in human) with no known
consensus sequences for kinase activity or for nucleotide-binding regions. The
biochemical nature of signals induced by the binding of IL-4 to its receptor have not been
5   elucidated. It does appear that the cytosolic domain of the receptor is essential for its
signaling function (Mosely et al., 1989). Ligand induced dimerization of the IL-4 receptor
appears to be a critical first step in IL-4 mediated signal transduction.

One of the major physiologic roles of IL-4 is as a B lymphocyte activation and
differentiation factor (Rabin et al., 1985; Oliver et al., 1985). The protein was first
10   isolated based on this activity. In this regard, IL-4 activates production of IgG1 (Vitetta et
al., 1985), but is also responsible for isotype switching in B cells from production of IgG
to IgE immunoglobulins (Coffman et al., 1986; Lebman and Coffman, 1988, Del Prete et
al., 1988). The effect of IL-4 on the in vivo regulation of IgE has been clearly
demonstrated. Neutralization of IL-4 by treatment with a monoclonal anti-IL-4 antibody
15   (Finkelman et al., 1986) or a monoclonal antibody to the IL-4 receptor (Finkelman et al.,
1990) will block the IgE response. A recombinant soluble IL-4 receptor has been shown
to inhibit IgE production by up to 85% in vivo (Sato et al., 1993). IL-4 deficient mice
produced by gene-targeting in murine embryonic stem cells have normal B and T cell
development, but serum levels of IgG1 and IgE are strongly reduced (Kuhn et al., 1991).
20   IL-4 augmented IgE production leads to an atopic state (allergy/asthma) (Finkelman et al.,
1989; Katona et al., 1991).

The IL-4 mediated up-regulation of IgG1 may play a role in the inflammation
cascade. IgG1 has recently been shown to form immune complexes which bind to the
cellular receptors for the Fc domain of immunoglobulins (FcRs) leading to an
25   inflammatory response (Sylvestre and Ravetch, 1994; Ravetch, 1994). IL-4 transgenic
mice have been produced that hyperexpress IL-4 (Tepper et al., 1990). These mice have
elevated levels of serum IgG1 and IgE and they develop allergic inflammatory disease.
These findings demonstrate the critical role IL-4 plays in the humoral immune response.

Another major physiologic role for IL-4 is as a T lymphocyte growth factor (Hu-Li
30   et al., 1987; Spits et al., 1987). IL-4 enhances the proliferation of precursors of cytotoxic
T cells (CTLs) and their differentiation into active CD8^{+} CTLs (Widmer and Grabstein,

1987; Trenn, 1988). IL-4 appears to augment the IL-2 driven induction of
lymphokine-activated killer (LAK) cells (Higuchi *et al.*, 1989), which have been shown to
lyse a variety of tumor cell targets without major histocompatibility complex (MHC)
restriction. The role played by IL-4 at this crucial nexus of T cell effector function is
5   fundamental to the success or failure of the immune response.

IL-4 has been shown to affect nonlymphoid hematopoietic cells in a variety of
ways. IL-4 has been shown to modulate monocyte/macrophage growth (McInnes and
Rennick, 1988; Jansen *et al.*, 1989) while enhancing their differentiation and cytotoxic
activity for certain tumor cells (Crawford,*et al.*, 1987; Te Velde *et al.*, 1988). IL-4 also
10   has activity as a stimulant of mast cell growth (Mosmann *et al.*, 1986; Brown *et al.*, 1987),
and increases production and recruitment of eosinophils (Tepper *et al.*, 1989).

IL-4 alone or in conjunction with other cytokines can promote the expression of a
variety of cell-surface molecules on various cell types with diverse implications for
disease. Specifically, IL-4 can interact with tumor necrosis factor (TNF) to selectively
15   enhance vascular cell adhesion molecule-1 (VCAM-1) expression contributing to T cell
extravasation at sites of inflammation (Briscoe *et al.*, 1992). IL-4 alone or in combination
with TNF or IFN-gamma has been shown to increase both MHC antigen and
tumor-associated antigen expression on a variety of neoplastic cells (Hoon *et al.*, 1991).

As detailed above, IgG1 immune complexes bind to the cellular receptors for the
20   Fc domain of immunoglobulins (FcRs) leading to an inflammatory response. Inhibition of
IL-4 and the subsequent reduction in IL-4 mediated IgG1 expression may prove
efficacious against immune complex inflammatory disease states. Indeed, inhibitory
ligands to IL-4 might also prevent the IL-4 mediated overexpression of VCAM-1, thus
attenuating the ability of T cells to extravasate at sites of inflammation.

25   Inhibition of IL-4 activity with a monoclonal antibody, a recombinant soluble IL-4
receptor, or gene knock-out, results in a reduction of serum IgE levels. An inhibitory
oligonucleotide ligand to IL-4 could be clinically effective against allergy and allergic
asthma.

A recent report has described a disorder in bone homeostasis in transgenic mice
30   that inappropriately express IL-4 under the direction of the lymphocyte-specific proximal
promoter for the *lck* gene (Lewis *et al.*, 1993). Bone disease in these mice resulted from

markedly decreased bone formation by osteoblasts, features identical to those found in human osteoporosis. Inhibiting this IL-4 mediated reduction in osteoblast activity may prove beneficial against osteoporosis.

Graft-versus-host disease (GVHD) is a major complication of human tissue

5   transplantation. GVHD does not exist as a single clinical manifestation but can involve immunologic abnormalities ranging from immunodeficiency to systemic autoimmunities (Ferrara *et al.*, 1991). These systemic autoimmunities include clinical and serological manifestations of human systemic lupus erythematosus (SLE). Several murine models of SLE have been developed (Gleichmann *et al.*, 1982; van Rappard-van Der Veen *et al.*,

10   1982), and the induction of systemic GVHD in mice has been described (Via *et al.*, 1988). Two recent studies have shown *in vivo* efficacy of a mouse monoclonal antibody to IL-4 in preventing GVHD and SLE in these murine model systems (Umland *et al.*, 1992; Ushiyama *et al.*, 1995). These observations suggest that an inhibitor of human IL-4 may be effective in treatment of chronic systemic autoimmunities such as SLE and GVHD.

15   A variety of microbicidal infections are characterized by depressed cellular but enhanced humoral immune responses, which suggests a T_{H2} type of response to infection. This T_{H2} phenotype is characterized by T cell secretion of IL-4, as detailed earlier. IL-4 blocks the microbicidal activity of IFN-gamma activated macrophages in fighting *Leishmania major* infection (Liew *et al.*, 1989; Leal *et al.*, 1993). Inhibition of IL-4

20   would enhance the T_{H1} effector arm of the immune response enhancing cellular immunity and leading to the resolution of infection. Neutralization of IL-4 *in vivo* allows mice otherwise susceptible to *Leishmania major* infection to fight off the parasite and clear the infection (Heinzel *et al.*, 1989). Several informative studies have looked at the T_{H1}/T_{H2} phenotypic distinction in infected mice, and suggest a T_{H1} dominated response being most

25   effective in fighting microbial infection (for a review, see Sher and Coffman, 1992).

IL-10

IL-10 is a cytokine produced by the Th2 cells, but not Th1 cells, and inhibits synthesis of most of all cytokines produced by Th1 cells but not Th2 cells (Mosmann *et al.*, 1991). In addition to the effect on $CD4^+$ cells with Th1 phenotype, IL-10 also inhibits

5   $CD8^+$ T cells with "Th1-like" phenotype. IL-10 is a potent suppressor of macrophage activation. It can suppress the production of proinflammatory cytokines, including $TNF\alpha$, IL-1, IL-6, IL-8 and IFN-gamma. Overall, these results suggest that IL-10 is a potent macrophage deactivator and an effective anti-inflammatory reagent. In addition, IL-10 prevents the IFN- g -induced synthesis of nitric oxide, resulting in decreased resistance to

10 intracellular parasites (Gazzinelli *et al.*, 1992).

Both human and mouse (hIL-10 and mIL-10, respectively) have been cloned and expressed (Moore *et al.*, 1990; Vieira *et al.*, 1991). The two cDNAs exhibit high degree of nucleotide sequence homology (>80%) throughout and encode very similar open reading frames (73% amino acid homology). Both proteins are expressed as noncovalent

15 homodimers that are acid labile (Moore *et al.*, 1993). Whether monomers are equally bioactive is not clear yet. Based on the primary structure IL-10 has been categorized into the four a-helix bundle family of cytokines (Shanafelt *et al.*,1991). Possibly due to high degree of sequence homology and similar structure hIL-10 has been shown to be active on mouse cells (Moore *et al.*, 1993) but not vice versa. hIL-10 is an 18 kDa polypeptide with

20 no detectable carbohydrate; however, in mIL-10 there is one N-linked glycosylation. The recombinant hIL-10 has been expressed in CHO cells, COS7 cells, mouse myeloma cells, the baculovirus expression system and *E. coli*. The rIL-10 expressed in these systems have indistinguishable biological behavior (Moore *et al.*,1993).

Parasitic infection often leads to polarized immune response of either Th1 or Th2

25 type which can mediate protection or susceptibility. The outcome of a parasitic infection depends on the nature of the parasite and the host. The best understood example is *Leishmania major* infection in mice. *L. major* is a protozoan parasite that establishes an intracellular infection in macrophages, where it is mainly localized in phagolysosomes. Activated macrophages can efficiently destroy the intracellular parasite and thus parasitic

30 protection is achieved by macrophage activation. Nonactivated macrophages do not kill these organisms. As expected, activation of macrophages upon IFN-gamma treatment

enhanced the protection, whereas IL-4 and IL-10 blocked the increased microbicidal

activity induced by IFN-gamma (Liew *et al.*, 1989). In most inbred strains (example,

C57/BL6) cutaneous infection of *L. major* often leads to localized infection with

spontaneous healing and confers resistance to reinfection. However, in BALB/c mice, *L.*

5   *major* infection induces nonprotective immune response by producing IL-4. The antibody

response mediated by IL-4 is ineffective and leads to death (Howard *et al.*, 1980). In

healing strains a strong Th1 response has been noticed with high level of IFN- g , whereas

in susceptible BALB/c mice a nonproductive Th2 response with significant levels of IL-4

was found (Heinzel *et al.*, 1991). Further it was shown that a single injection of

10   monoclonal anti-IFN-gamma antibody can convert a resistance into a susceptible mouse

(Belosevic *et al.*, 1989). As expected, the treatment of BALB/c mice with anti-IL-4

antibody led to the development of Th1 response and healing (Sher & Coffman, 1992).

Thus, depending on the nature of the pathogen, changing the immune response to a T cell

subset with a protective phenotype can lead to therapeutic intervention of the disease state.

15   Understanding the regulation between the Th1 and Th2 phenotype mediated by cytokines

will help in designing cytokine-antagonist in therapeutics. The production of IL-10 is

strongly increased in mice infected with various pathogens such as *Leishmania major*,

Schistosoma mansoni, *Trypanosoma cruzi* and *Mycobacterium Leprae* (Sher *et al*, 1992;

Salgame *et al.*, 1991, Heinzel *et al.*, 1991).

20   When designing immune therapy to facilitate mounting the right arm of defense

mechanism toward pathogens, it is important to maintain a balance between the two arms

also. Th2-type responses may be important in controlling the tissue damage mediated by

Th1 cells during the response to an intracellular infectious agent. Keeping some Th1 cells

functioning in a predominantly Th2 environment can help abrogate damaging effects of

25   Th1 by secreting IL-10 and IL-4. One extreme of the spectrum of Th1/Th2 is reflected in

transgenic mice lacking the IL-10 gene (Kuhn *et al.*, 1993). The IL-10 deficient mouse is

normal with respect to its development of T and B cell subsets. However these mice

develop chronic enterocolitis (or inflammatory bowel disease) due to chronic

inflammation via continuous overproduction of cytokines such as TNFα and

30   IFN-gamma(Th1 response).

IL-12 can also induce the development of the Th1 subset. By using *Lysteria monocytogen*, an intracellular gram-positive bacterium, infection in antibody T cell receptor transgenic mice as a model it has been shown that IL-10 can block the production of IL-12 from macrophages (Hsieh *et al.*,1993) . Thus an IL-10-antagonist will tip the

5   Th1/Th2 population predominantly to Th2 type environment by 1, preventing the inhibition of the production of Th1 cytokines 2 by allowing the production of a cytokine that induces the development of Th1 subset.

With experimental evidence in hand it has been proposed that the resistance and/or progression to AIDS is dependent on a Th1/Th2 stage of an individual (Clerici & Shearer,

10   1993). This hypothesis is based on the findings that progression to AIDS is characterized by loss of IL-2 and IFN-gamma production (loss of Th1 response) with increase in IL-4 and IL-10 (acquired Th2 response). Many seronegatives (HIV-exposed individuals) generate a strong Th1-type response. It is important to note that after seroconversion both IL-4 and IL-10 levels go up at the expense of IL-4 and IFN-gamma. However, in

15   full-blown AIDS patients, Th2 response seems to be mediated by high levels of IL-10 but not with IL-4, the level of which goes down to normal in these individuals. An anti-IL-10 reagent may serve as a potential therapeutic in shifting the Th2 response to Th1 in AIDS patients to offer protection.

20   **TNFα**

TNFα is an extracellular cytokine and a central mediator of the immune and inflammatory response (Beutler *et al.*, 1989; Vassalli, 1992). It is a homo-trimer (Smith *et al.*, 1987, Eck *et al.*, 1988), and has a subunit size of 17 kD. It circulates at concentrations of less than 5 pg/ml in healthy individuals (Dinarello *et al.*, 1993) and it can go as high as

25   1000 pg/ml in patients with sepsis syndrome (Casey *et al.*, 1993). The human TNFα is nonglycosylated, whereas in some other species (notably the mouse) glycosylation occurs on a single N-linked site in the mature protein, but the sugar moiety is not essential for biological activity (Beutler *et al.*, 1989). The human TNFα is acidic with a pH of 5.3 (Aggarwal *et al.*, 1985). Each TNFα subunit consists of an anti parallel ß-sandwich and it

30   participates in a trimer formation by an edge-to-face packing of ß-sheets. The structure of the TNFα trimer resembles the "jelly-roll" structural motif characteristic of viral coat

proteins (Jones *et al.*, 1989). TNFα is a relatively stable molecule and may be exposed to chaotropic agents such as urea, SDS, or guanidinium hydrochloride, and renatured with recovery of as much as 50% of the initial biological activity. The TNFα renaturability may reflect the limited number of internal disulfide bonds (one per monomer) required for

5   maintenance of structure (Beutler *et al.*, 1989).

Another related molecule, TNFß, has the same bioactivity as TNFa . The interspecies sequence identity within the TNFα and TNFß families is 71% and 61%, respectively (Beutler *et al.*, 1989). The sequence identity between hTNF-α and hTNF-ß is only 29% (Beutler *et al.*, 1989). Despite their low similarity, both hTNFα and hTNFß

10   bind to the same receptors with comparable affinities.

TNFα mediates its bioactivity through binding to cell surface receptors. The TNFα receptors are found on the surface of virtually all somatic cells tested (Vassalli, 1992). Two distinct TNFα receptors have been characterized of apparent molecular weights 55kD (p55 TNFα-R1) and 75kD (p75 TNFα-R2) (Hohmann *et al.*, 1989;

15   Brockhaus *et al.*, 1990; Loetscher *et al.*, 1991). Both receptors bind TNFα and TNFß with high affinities (Kd=0.3-0.6 nM) (Loetscher *et al.*, 1990; Schall *et al.*, 1990; Pennica *et al.*, 1992).

TNFα has diverse activities, and thus is implicated in several diseases as follows:

Septic shock. Sepsis incidents have been increasing for the last 60 years and is the

20   most common cause of death in intensive care units in the United States (Parrillo, 1991). The mortality of septic shock remains at approximately 50% despite the standard use of aggressive antibiotics and cardiovascular support for the past 10 years (Parrillo, 1991). The evidence implicating TNFα in sepsis is as follows. Pretreatment of mice or baboons with monoclonal antibodies to TNFα protects them from lethal doses of *E. coli* LPS

25   (Beutler *et al.*, 1985). Anti-TNFα antibodies protect primates against lethal endotoxin sepsis and against lethal *S. aureus*-induced shock (Fiedler *et al.*, 1992; Hinshaw *et al.*, 1992). Soluble-TNFα-receptor (p55)-IgG-Fc fusions (TNFα receptor immunoadhesin) were found to protect mice from endotoxic shock, even when administered 1hr after endotoxin infusion. The same immunoadhesin was also effective against listeriosis in

30   mice (Haak-Frendscho *et al.*, 1994). Another immunoadhesin based on the p75 receptor

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was also shown to be effective in lethal endotoxemia and it was functioning

simultaneously as both TNFα carrier and TNFα antagonist (Mohler *et al.*, 1993).

Cachexia. *In vivo* administration of TNFα causes cachexia in mice (Oliff *et al.*,

1987). Therefore, TNFα antagonists may protect cancer or AIDS infected patients from

5   cachexia.

Cerebral malaria. High levels of TNFα are associated with poor prognosis in

children with cerebral malaria, and antibodies to TNF a protect mice from cerebral

complications of *Plasmodium berghei* infection (Grau *et al.*, 1987).

Arthritis. Antibodies to TNFα reduce the production of the inflammatory

10   cytokine, IL-1 in synovial cells (Brennan *et al.*, 1989). TNF α is an inducer of

collagenase, the major destructive protease in rheumatoid arthritis (Brennan *et al.*, 1989).

Anti-TNF α antibodies were found to ameliorate joint disease in murine collagen-induced

arthritis (Williams *et al.*, 1992). Transgenic mice carrying the hTNFα gene develop

arthritis which can be prevented by *in vivo* administration of a monoclonal antibody

15   against hTNFα (Keffer *et al.*, 1991).

Graft Rejection and Graft versus Host Reaction (GVHR). TNFα has been

implicated in the acute phase of graft-versus-host disease and in renal allograft rejection.

Antagonists of TNFα may then be able to prevent these life-threatening conditions.

Anti-TNFα antibodies have been found to delay graft rejection in experimental animals

20   (Piguet, 1992). Also, injection of anti-TNFα antibodies during the acute phase of GVHR

reduces mortality, and the severity of intestinal, epidermal, and alveolar lesions (Piguet,

1992). Clinical trials of the efficacy of anti-TNFα antibody in human bone marrow

transplantation are underway.

AIDS. Studies of intracellular signal transduction pathways revealed that TNFα

25   induces proteins that bind to kB-like enhancer elements and thus takes part in the control

of NF-kB-inducible genes (Lenardo *et al.*, 1989; Lowenthal *et al.*, 1989; Osborn *et al.*,

1989). The antiviral activity of TNFα at least in part is mediated by the interaction of

NF-kB with a virus-inducible element in the ß-interferon gene (Goldfeld *et al.*, 1989;

Visvanathan *et al.*, 1989). By an analogous mechanism, TNFα appears to activate human

30   ·immunodeficiency virus type I (Duh *et al.*, 1989; Folks *et al.*, 1989). Therefore, TNFα

antagonists may prove useful in delaying the activation of the AIDS virus and may work
in conjunction with other treatments in the cure of AIDS.

      Parkinson's disease. Recently, elevated TNFα levels have been found in the brain
and the cerebrospinal fluid of Parkinsonian patients (Mogi *et al.*, 1994). This report
5   speculates that elevated TNFα levels may be related to neuronal degeneration associated
with the disease.

RANTES

      RANTES is a small (MW 8-kD) highly basic (pI~9.5) chemokine that belongs to
10 the CC group (Schall, 1991; Baggiolini *et al.*, 1994). It does not appear to be glycosylated
(Schall, 1991) and is a chemoattractant for monocytes (Schall *et al.*, 1990; Wang *et al.*,
1993; Wiedermann *et al.*, 1993), basophils (Bischoff *et al.*, 1993; Kuna *et al.*, 1993),
eosinophils (Rot *et al.*, 1992), and CD4$^+$/UCHL1$^+$ T lymphocytes which are thought to be
prestimulated or primed helper T cells involved in memory T cell function (Schall *et al.*,
15 1990). RANTES is not only a chemoattractant but it also stimulates cells to release their
effectors leading to tissue damage. For example, RANTES causes histamine release from
basophils (Kuna *et al.*, 1992; Kuna *et al.*, 1993; Alam *et al.*, 1993). It also causes the
secretion of eosinophil basic peptide (Alam *et al.*, 1993) and the production of oxygen free
radicals (Rot *et al.*, 1992) by eosinophils.

20   Initially, it was thought that RANTES was synthesized by activated T cells but
recently other cells were found to synthesize it very fast upon stimulation. RANTES
mRNA is expressed late (3 to 5 days) after activation of resting T cells, whereas in
fibroblasts, renal epithelial and mesangial cells, RANTES mRNA is quickly up-regulated
by TNFα stimulation (Nelson *et al.*, 1993).

25   Receptors for RANTES have been identified. There is a promiscuous receptor on
the surface of erythrocytes that binds all chemokines with a Kd=5nM (Horuk *et al.*, 1993;
Neote *et al.*, 1993). This receptor is thought to be a sink for chemokines to help in the
establishment of chemotactic gradients. Signal transducing receptors have also been
identified and cloned (Gao *et al.*, 1993; Neote *et al.*, 1993; Van-Riper *et al.*, 1993; Wang
30 *et al.*, 1993). *Monocytes* carry a G-protein coupled receptor that binds RANTES with
estimated Kd of 400 pM, but also MCAF and MIP-1a with lower affinities (estimated Kd

of 6 and 1.6 nM respectively) (Wang *et al.*, 1993). A receptor molecule has been cloned from neutrophils that can bind RANTES with a lower affinity of about 50 nM (Gao *et al.*, 1993).

 Disease State. RANTES antagonists may have therapeutic application in

5 inflammation. Blockage of the chemoattractant and effector cell activation properties of RANTES would block local inflammation and tissue damage. The mechanism of action of the RANTES antagonist will be the inhibition of RANTES binding to cell surface receptors.

 RANTES is chemoattractant for monocytes, basophils, eosinophils and memory

10 lymphocytes. Basophils are the major source of mediators such as histamine and peptido-leukotrienes, and are an essential element of the late-phase responses to allergens in hypersensitivity diseases. These cells are also involved in other inflammatory pathologies, including certain autoimmune reactions, parasitic infections and inflammatory bowel diseases. In these conditions, basophil recruitement and activation is independent

15 of IgE. Numerous reports have accumulated over the years that describe the effects of a group of elusive stimuli operationally called "histamine-releasing factors." A large number of these elusive stimuli may well be contributed by RANTES.

 Eosinophiles also are important in allergic inflamation, and together with lymphocytes, form prominent infiltrates in the bronchial mucosa of patients with asthma.

20 They are believed to be the cause of epithelial damage and the characteristic airway hyper-reactivity. The recruitement of lymphocytes of the Th2 type, which comigrate with eosinophiles into sites of late-phase reactions, is an important source of other chemoattractant cytokines and growth factors that prime eosinophils.

 RANTES, with its effects on monocytes, basophils, eosinophils and lymphocytes

25 appears to be a potent stimulator of effector-cell accumulation and activation in chronic inflammatory diseases and in particular, allergic inflammation.

 The recruitement system of inflammatory cells has some redundancy built into it. However, RANTES has some unique properties. It is a more potent chemoattractant than MCP-1 and MIP-1 a , while MCP-1 is more potent stimulator of histamine release from

30 basophils (Baggiolini *et al.*, 1994). RANTES causes the production of oxygen radicals by eosinophiles while MIP-1 a cannot (Rot *et al.*, 1992). RANTES is as potent as C5a in the

recruitement of eosinphiles, but not as potent a trigger of the eosinophil oxydation burst
(Rot *et al.*, 1992). C5a is a very potent chemoattractant: however, it lacks the specificity
of RANTES. It attracts not only basophils and eosinophils but also neutrophils. Since the
eosinophils, but not the neutrophils, are important in the pathophysiology of some

5   inflammatory conditions, such as the allergen-induced late-phase reaction and asthma,
specific chemoattractants such as RANTES are expected to be involved.

Using *in situ* hybridization, RANTES expression has been found in interstitial
mononuclear cells and proximal tubular epithelial cells in human kidney transplants
undergoing rejection. Antibody staining revealed the presence of RANTES not only

10 within the interstitial infiltrate and renal tubular epithelial cells but also in high abundance
in inflamed endothelium (Wiedermann *et al.*, 1993). Based on these results a haptotactic
mechanism was postulated. Haptotaxis is defined as cell migration induced by
surface-bound gradients. The haptotactic mechanism was supported by *in vitro*
experiments and anti-RANTES antibodies have been found to prevent that *in vitro*

15 haptotaxis.

Human rheumatoid synovial fibroblasts express mRNA for RANTES and IL-8
after stimulation with TNFa and IL-1ß (Rathanaswami *et al.*, 1993). There is a
differential regulation of expression of IL-8 and RANTES mRNA. Cycloheximide
enhanced the mRNA levels for IL-8 and RANTES after stimulation with IL-1ß but

20 reduced the levels of RANTES mRNA after stimulation with TNFα. Also, IL-4
down-regulates and IFN-gamma enhances the TNFα and IL-1ß induced increase in
RANTES mRNA, whereas the induction of IL-8 mRNA by TNFα or IL-1ß was inhibited
by IFN-gamma and augmented by IL-4. Moreover, the combination of TNFα and IL-1ß
synergistically increased the level of IL-8 mRNA, whereas under the same conditions, the

25 levels of RANTES mRNA were less than those induced with TNFα alone. These studies
suggest that the synovial fibroblasts may participate in the ongoing inflammatory process
in rheumatoid arthritis, and RANTES might be one of the participating effectors. The
observed differential regulation of IL-8 and RANTES indicates that the type of cellular
infiltrate and the progress of the inflammatory disease is likely to depend on the relative

30 levels of stimulatory and inhibitory cytokines.

RANTES has also been implicated in atherosclerosis and possibly in postangioplasty restenosis (Schall, 1991). The participation of MCP-1 in atherosclerosis has been studied to a greater extent. Recently mRNAs for RANTES, MIP-1 a and MIP-1ß have been detected in _in situ_ in normal carotid plaque and heart transplant

5 atherosclerosis. RANTES mRNA is not detected in the same cells expressing MIP-1a and MIP-1ß, but it is expressed in lymphocytes and macrophages typically more proximal to the lumen. The data argue for positive feed-back mechanisms for the CC chemokines and possible differential expression of these chemokines at various stages in the progression of arterial disease.

10 Finally, elevated RANTES levels have been correlated with endometriosis (Khorram _et al._, 1993). RANTES levels were elevated in pelvic fluids from women with endometriosis, and these levels correlate with the severity of the disease.

Protein Homology between Human and Animal. The murine RANTES has been cloned (Schall _et al._, 1992). Sequence analysis revealed 85% amino acid identity between

15 the human and mouse proteins. The human and murine RANTES exhibit immune crossreactivity. Boyden chamber chemotaxis experiments reveal some lack of species specificity in monocyte chemoattractant potential, as recombinant muRANTES attracts human monocytes in a dose-dependent fashion _in vitro_. Also, hRANTES transfection into mouse tumor cell lines produce tumors in which the secretion of hRANTES by those

20 tumors correlates with increased murine monocyte infiltration _in vivo_ (Schall _et al._, 1992).

SELEX

A method for the _in vitro_ evolution of nucleic acid molecules with highly specific binding to target molecules has been developed. This method, Systematic Evolution of

25 Ligands by EXponential enrichment, termed SELEX, is described in United States Patent Application Serial No. 07/536,428, entitled "Systematic Evolution of Ligands by Exponential Enrichment," now abandoned, United States Patent Application Serial No. 07/714,131, filed June 10, 1991, entitled "Nucleic Acid Ligands," United States Patent Application Serial No. 07/931,473, filed August 17, 1992, entitled "Nucleic Acid

30 Ligands," now United States Patent No. 5,270,163 (see also PCT/US91/04078), each of which is herein specifically incorporated by reference. Each of these applications,

collectively referred to herein as the SELEX Patent Applications, describes a fundamentally novel method for making a nucleic acid ligand to any desired target molecule.

The SELEX method involves selection from a mixture of candidate

5   oligonucleotides and step-wise iterations of binding, partitioning and amplification, using the same general selection scheme, to achieve virtually any desired criterion of binding affinity and selectivity. Starting from a mixture of nucleic acids, preferably comprising a segment of randomized sequence, the SELEX method includes steps of contacting the mixture with the target under conditions favorable for binding, partitioning unbound

10   nucleic acids from those nucleic acids which have bound specifically to target molecules, dissociating the nucleic acid-target complexes, amplifying the nucleic acids dissociated from the nucleic acid-target complexes to yield a ligand-enriched mixture of nucleic acids, then reiterating the steps of binding, partitioning, dissociating and amplifying through as many cycles as desired to yield highly specific, high affinity nucleic acid ligands to the

15   target molecule.

The basic SELEX method has been modified to achieve a number of specific objectives. For example, United States Patent Application Serial No. 07/960,093, filed October 14, 1992, entitled "Method for Selecting Nucleic Acids on the Basis of Structure," describes the use of SELEX in conjunction with gel electrophoresis to select nucleic acid

20   molecules with specific structural characteristics, such as bent DNA. United States Patent Application Serial No. 08/123,935, filed September 17, 1993, entitled "Photoselection of Nucleic Acid Ligands" describes a SELEX based method for selecting nucleic acid ligands containing photoreactive groups capable of binding and/or photocrosslinking to and/or photoinactivating a target molecule. United States Patent Application Serial No.

25   08/134,028, filed October 7, 1993, entitled "High-Affinity Nucleic Acid Ligands That Discriminate Between Theophylline and Caffeine," describes a method for identifying highly specific nucleic acid ligands able to discriminate between closely related molecules, termed Counter-SELEX. United States Patent Application Serial No. 08/143,564, filed October 25, 1993, entitled "Systematic Evolution of Ligands by EXponential Enrichment:

30   Solution SELEX," describes a SELEX-based method which achieves highly efficient partitioning between oligonucleotides having high and low affinity for a target molecule.

United States Patent Application Serial No. 07/964,624, filed October 21, 1992, entitled "Methods of Producing Nucleic Acid Ligands" describes methods for obtaining improved nucleic acid ligands after SELEX has been performed. United States Patent Application Serial No. 08/400,440, filed March 8, 1995, entitled "Systematic Evolution of Ligands by

5   EXponential Enrichment: Chemi-SELEX," describes methods for covalently linking a ligand to its target.

The SELEX method encompasses the identification of high-affinity nucleic acid ligands containing modified nucleotides conferring improved characteristics on the ligand, such as improved *in vivo* stability or improved delivery characteristics. Examples of such

10   modifications include chemical substitutions at the ribose and/or phosphate and/or base positions. SELEX-identified nucleic acid ligands containing modified nucleotides are described in United States Patent Application Serial No. 08/117,991, filed September 8, 1993, entitled "High Affinity Nucleic Acid Ligands Containing Modified Nucleotides," that describes oligonucleotides containing nucleotide derivatives chemically modified at

15   the 5- and 2'-positions of pyrimidines. United States Patent Application Serial No. 08/134,028, *supra*, describes highly specific nucleic acid ligands containing one or more nucleotides modified with 2'-amino (2'-NH_2), 2'-fluoro (2'-F), and/or 2'-O-methyl (2'-OMe). United States Patent Application Serial No. 08/264,029, filed June 22, 1994, entitled "Novel Method of Preparation of 2' Modified Pyrimidine Intramolecular

20   Nucleophilic Displacement," describes oligonucleotides containing various 2'-modified pyrimidines.

The SELEX method encompasses combining selected oligonucleotides with other selected oligonucleotides and non-oligonucleotide functional units as described in United States Patent Application Serial No. 08/284,063, filed August 2, 1994, entitled

25   "Systematic Evolution of Ligands by Exponential Enrichment: Chimeric SELEX" and United States Patent Application Serial No. 08/234,997, filed April 28, 1994, entitled "Systematic Evolution of Ligands by Exponential Enrichment: Blended SELEX," respectively. These applications allow the combination of the broad array of shapes and other properties, and the efficient amplification and replication properties, of

30   oligonucleotides with the desirable properties of other molecules. Each of the above

described patent applications which describe modifications of the basic SELEX procedure are specifically incorporated by reference herein in their entirety.

BRIEF SUMMARY OF THE INVENTION

5   The present invention includes methods of identifying and producing nucleic acid ligands to cytokines and the nucleic acid ligands so identified and produced. In particular, RNA sequences are provided that are capable of binding specifically to IFN-gamma, IL-4, IL-10, and TNFα. In addition, DNA sequences are provided that are capable of binding specifically to RANTES. Specifically included in the invention are the RNA ligand.

10   sequences shown in Tables 3, 4, 7, 8, 10, and 12 (SEQ ID NOS:7-73; 79-185; 189-205; 209-255).

        Further included in this invention is a method of identifying nucleic acid ligands and nucleic acid ligand sequences to a cytokine comprising the steps of (a) preparing a candidate mixture of nucleic acids, (b) contacting the candidate mixture of nucleic acids

15   with a cytokine, (c) partitioning between members of said candidate mixture on the basis of affinity to the cytokine, and (d) amplifying the selected molecules to yield a mixture of nucleic acids enriched for nucleic acid sequences with a relatively higher affinity for binding to the cytokine.

        Further included in this invention is a method of identifying nucleic acid ligands

20   and nucleic acid ligand sequences to a cytokine selected from the group consisting of IFN-gamma, IL-4, IL-10, TNFα, and RANTES comprising the steps of (a) preparing a candidate mixture of nucleic acids, (b) contacting the candidate mixture of nucleic acids with said cytokine, (c) partitioning between members of said candidate mixture on the basis of affinity to said cytokine, and (d) amplifying the selected molecules to yield a

25   mixture of nucleic acids enriched for nucleic acid sequences with a relatively higher affinity for binding to said cytokine.

        More specifically, the present invention includes the RNA ligands to IFN-gamma, IL-4, IL-10, and TNFα identified according to the above-described method, including those ligands shown in Tables 3, 4, 7, 8, 10, and 12 (SEQ ID NOS:7-73; 79-185; 189-205;

30   209-255). Also included are RNA ligands to IFN-gamma, IL-4, IL-10, and TNFα that are substantially homologous to any of the given ligands and that have substantially the same

ability to bind IFN-gamma, IL-4, IL-10, and TNFα and inhibit the function of

IFN-gamma, IL-4, IL-10, and TNFα. Further included in this invention are nucleic acid

ligands to IFN-gamma, IL-4, IL-10, and TNFα that have substantially the same structural

form as the ligands presented herein and that have substantially the same ability to bind

5   IFN-gamma, IL-4, IL-10, and TNFα and inhibit the function of IFN-gamma, IL-4, IL-10,

and TNFα.

The present invention also includes modified nucleotide sequences based on the

nucleic acid ligands identified herein and mixtures of the same.

10   <u>**DETAILED DESCRIPTION OF THE INVENTION**</u>

This application describes high-affinity nucleic acid ligands to cytokines identified

through the method known as SELEX. SELEX is described in U.S. Patent Application

Serial No. 07/536,428, entitled Systematic Evolution of Ligands by EXponential

Enrichment, now abandoned, U.S. Patent Application Serial No. 07/714,131, filed June

15   10, 1991, entitled Nucleic Acid Ligands, United States Patent Application Serial No.

07/931,473, filed August 17, 1992, entitled Nucleic Acid Ligands, now United States

Patent No. 5,270,163, (see also PCT/US91/04078). These applications, each specifically

incorporated herein by reference, are collectively called the SELEX Patent Applications.

In its most basic form, the SELEX process may be defined by the following series

20   of steps:

1) A candidate mixture of nucleic acids of differing sequence is prepared. The

candidate mixture generally includes regions of fixed sequences (i.e., each of the members

of the candidate mixture contains the same sequences in the same location) and regions of

randomized sequences. The fixed sequence regions are selected either: (a) to assist in the

25   amplification steps described below, (b) to mimic a sequence known to bind to the target,

or (c) to enhance the concentration of a given structural arrangement of the nucleic acids in

the candidate mixture. The randomized sequences can be totally randomized (i.e., the

probability of finding a base at any position being one in four) or only partially

randomized (e.g., the probability of finding a base at any location can be selected at any

30   level between 0 and 100 percent).

2) The candidate mixture is contacted with the selected target under conditions favorable for binding between the target and members of the candidate mixture. Under these circumstances, the interaction between the target and the nucleic acids of the candidate mixture can be considered as forming nucleic acid-target pairs between the

5   target and those nucleic acids having the strongest affinity for the target.

3) The nucleic acids with the highest affinity for the target are partitioned from those nucleic acids with lesser affinity to the target. Because only an extremely small number of sequences (and possibly only one molecule of nucleic acid) corresponding to the highest affinity nucleic acids exist in the candidate mixture, it is generally desirable to

10   set the partitioning criteria so that a significant amount of the nucleic acids in the candidate mixture (approximately 5-50%) are retained during partitioning.

4) Those nucleic acids selected during partitioning as having the relatively higher affinity to the target are then amplified to create a new candidate mixture that is enriched in nucleic acids having a relatively higher affinity for the target.

15   5) By repeating the partitioning and amplifying steps above, the newly formed candidate mixture contains fewer and fewer weakly binding sequences, and the average degree of affinity of the nucleic acids to the target will generally increase. Taken to its extreme, the SELEX process will yield a candidate mixture containing one or a small number of unique nucleic acids representing those nucleic acids from the original

20   candidate mixture having the highest affinity to the target molecule.

The SELEX Patent Applications describe and elaborate on this process in great detail. Included are targets that can be used in the process; methods for partitioning nucleic acids within a candidate mixture; and methods for amplifying partitioned nucleic acids to generate enriched candidate mixture. The SELEX Patent Applications also

25   describe ligands obtained to a number of target species, including both protein targets where the protein is and is not a nucleic acid binding protein.

The nucleic acid ligands described herein can be complexed with a lipophilic compound (e.g., cholesterol) or attached to or encapsulated in a complex comprised of lipophilic components (e.g., a liposome). The complexed nucleic acid ligands can enhance

30   the cellular uptake of the nucleic acid ligands by a cell for delivery of the nucleic acid ligands to an intracellular target. U.S. Patent Application No. 08/434,465, filed May 4,

1995, entitled "Nucleic Acid Ligand Complexes," which is incorporated in its entirety herein, describes a method for preparing a therapeutic or diagnostic complex comprised of a nucleic acid ligand and a lipophilic compound or a non-immunogenic, high molecular weight compound.

5   The methods described herein and the nucleic acid ligands identified by such methods are useful for both therapeutic and diagnostic purposes. Therapeutic uses include the treatment or prevention of diseases or medical conditions in human patients. Diagnostic utilization may include both *in vivo* or *in vitro* diagnostic applications. The SELEX method generally, and the specific adaptations of the SELEX method taught and

10   claimed herein specifically, are particularly suited for diagnostic applications. SELEX identifies nucleic acid ligands that are able to bind targets with high affinity and with surprising specificity. These characteristics are, of course, the desired properties one skilled in the art would seek in a diagnostic ligand.

          The nucleic acid ligands of the present invention may be routinely adapted for

15   diagnostic purposes according to any number of techniques employed by those skilled in the art. Diagnostic agents need only be able to allow the user to identify the presence of a given target at a particular locale or concentration. Simply the ability to form binding pairs with the target may be sufficient to trigger a positive signal for diagnostic purposes. Those skilled in the art would also be able to adapt any nucleic acid ligand by procedures

20   known in the art to incorporate a labeling tag in order to track the presence of such ligand. Such a tag could be used in a number of diagnostic procedures. The nucleic acid ligands to cytokines described herein may specifically be used for identification of the cytokine proteins.

          SELEX provides high affinity ligands of a target molecule. This represents a

25   singular achievement that is unprecedented in the field of nucleic acids research. The present invention applies the SELEX procedure to the specific target. In the Example section below, the experimental parameters used to isolate and identify the nucleic acid ligands to cytokines are described.

          In order to produce nucleic acids desirable for use as a pharmaceutical, it is

30   preferred that the nucleic acid ligand (1) binds to the target in a manner capable of achieving the desired effect on the target; (2) be as small as possible to obtain the desired

effect; (3) be as stable as possible; and (4) be a specific ligand to the chosen target. In

most situations, it is preferred that the nucleic acid ligand have the highest possible affinity

to the target.

In co-pending and commonly assigned U.S. Patent Application Serial No.

5   07/964,624, filed October 21, 1992 ('624), methods are described for obtaining improved

nucleic acid ligands after SELEX has been performed. The '624 application, entitled

Methods of Producing Nucleic Acid Ligands, is specifically incorporated herein by

reference.

This invention includes the SELEX process for identification of nucleic acid

10   ligands of cytokines. Cytokines are a diverse group of small proteins that mediate cell

signaling/communication. Cytokines include immune/ hematopoietins (e.g.,EPO,

GM-CSF, G-CSF, LIF, OSM, CNTF, GH, PRL, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-9,

IL-10, IL-12), interferons (e.g.,IFNα, IFNβ, IFN-gamma), TNF-related molecules

(e.g.,TNFα, IFNβ, gp^{39} (CD40-L), CD27-L, CD30-L,NGF), and chemokines (e.g, PF4,

15   PBP, groα, MIG, ENA-78, MIP1α, MIP1β, MCP-1, I-309, HC14, C10, RANTES, IL-8,

MIP-1). In one embodiment, cytokines are derived from T-lymphocytes.

In the present invention, SELEX experiments were performed in order to identify

RNA with specific high affinity for the cytokines IFN-gamma, IL-4, IL-10, hTNFα, and

RANTES from degenerate libraries containing 30 or 40 random positions (40N for

20   IFN-gamma, IL-4, IL-10 and RANTES; 30N for hTNFα) (Tables 1, 5, 9, 11, and 16).

This invention includes the specific RNA ligands to IFN-gamma, IL-4, IL-10, and TNFα

shown in Tables 3, 4, 7, 8, 10, and 12 (SEQ ID NOS:7-73; 79-185; 189-205; 209-255),

identified by the methods described in Examples 1, 3, 5, 7, and 12. This invention further

includes RNA ligands to IFN-gamma, IL-4, IL-10, and TNFα which inhibit the function of

25   IFN-gamma, IL-4, IL-10, and TNFα. This invention further includes DNA ligands to

RANTES which inhibit the function of RANTES. The scope of the ligands covered by

this invention extends to all nucleic acid ligands of IFN-gamma, IL-4, IL-10, TNF a, and

RANTES modified and unmodified, identified according to the SELEX procedure. More

specifically, this invention includes nucleic acid sequences that are substantially

30   homologous to the ligands shown in Tables 3, 4, 7, 8, 10, and 12 (SEQ ID NOS:7-73;

79-185; 189-205; 209-255). By substantially homologous it is meant a degree of primary

sequence homology in excess of 70%, most preferably in excess of 80%. A review of the sequence homologies of the ligands of IFN-gamma, IL-4, IL-10, and TNFα shown in Tables 3, 4, 7, 8, 10, and 12 (SEQ ID NOS:7-73; 79-185; 189-205; 209-255) shows that sequences with little or no primary homology may have substantially the same ability to

5 bind IFN-gamma, IL-4, IL-10, and TNFα. For these reasons, this invention also includes nucleic acid ligands that have substantially the same structure and ability to bind IFN-gamma, IL-4, IL-10, and TNFα as the nucleic acid ligands shown in Tables 3, 4, 7, 8, 10, and 12 (SEQ ID NOS:7-73; 79-185; 189-205; 209-255). Substantially the same ability to bind IFN-gamma, IL-4, IL-10, and TNFα means that the affinity is within one or two

10 orders of magnitude of the affinity of the ligands described herein. It is well within the skill of those of ordinary skill in the art to determine whether a given sequence -- substantially homologous to those specifically described herein -- has substantially the same ability to bind IFN-gamma, IL-4, IL-10, and TNFα.

This invention also includes the ligands as described above, wherein certain

15 chemical modifications are made in order to increase the *in vivo* stability of the ligand or to enhance or mediate the delivery of the ligand. Examples of such modifications include chemical substitutions at the sugar and/ or phosphate and/or base positions of a given nucleic acid sequence. See, e.g., U.S. Patent Application Serial No. 08/117,991, filed September 9, 1993, entitled High Affinity Nucleic Acid Ligands Containing Modified

20 Nucleotides which is specifically incorporated herein by reference. Other modifications are known to one of ordinary skill in the art. Such modifications may be made post-SELEX (modification of previously identified unmodified ligands) or by incorporation into the SELEX process.

As described above, because of their ability to selectively bind IFN-gamma, IL-4,

25 IL-10, hTNFα, and RANTES, the nucleic acid ligands to IFN-gamma, IL-4, IL-10,TNFα, and RANTES described herein are useful as pharmaceuticals. This invention, therefore, also includes a method of inhibiting cytokine function by administration of a nucleic acid ligand capable of binding to a cytokine.

Therapeutic compositions of the nucleic acid ligands may be administered

30 parenterally by injection, although other effective administration forms, such as intraarticular injection, inhalant mists, orally active formulations, transdermal

iontophoresis or suppositories, are also envisioned. One preferred carrier is physiological

saline solution, but it is contemplated that other pharmaceutically acceptable carriers may

also be used. In one preferred embodiment, it is envisioned that the carrier and the ligand

constitute a physiologically-compatible, slow release formulation. The primary solvent in

5   such a carrier may be either aqueous or non-aqueous in nature. In addition, the carrier may

contain other pharmacologically-acceptable excipients for modifying or maintaining the

pH, osmolarity, viscosity, clarity, color, sterility, stability, rate of dissolution, or odor of

the formulation. Similarly, the carrier may contain still other

pharmacologically-acceptable excipients for modifying or maintaining the stability, rate of

10   dissolution, release, or absorption of the ligand. Such excipients are those substances

usually and customarily employed to formulate dosages for parental administration in

either unit dose or multi-dose form.

        Once the therapeutic composition has been formulated, it may be stored in sterile

vials as a solution, suspension, gel, emulsion, solid, or dehydrated or lyophilized powder.

15   Such formulations may be stored either in a ready to use form or requiring reconstitution

immediately prior to administration. The manner of administering formulations

containing nucleic acid ligands for systemic delivery may be via subcutaneous,

intramuscular, intravenous, intranasal or vaginal or rectal suppository.

        The following Examples are provided to explain and illustrate the present

20   invention and are not intended to be limiting of the invention.

EXAMPLE 1. EXPERIMENTAL PROCEDURES FOR 2'-NH₂ AND 2'-
F-MODIFIED LIGANDS TO IFN-GAMMA

        This example provides general procedures followed and incorporated in Example 2

25   for the evolution of nucleic acid ligands to IFN-gamma.

        A. Oligonucleotides

        2'F modified CTP and UTP were prepared according to the method of Pieken *et al.*,

1991. 2'NH₂ modified CTP and UTP were prepared according to the method of McGee *et*

al., U.S. Patent Application No. 08/264,029, filed June 22, 1994, which is incorporated

30   herein by reference (see also McGee *et al.* 1995). DNA oligonucleotides were

synthesized by Operon Technologies (Alameda CA).

B. SELEX

The SELEX procedure has been described in detail in U.S. Patent No. 5,270,163 (see also Tuerk and Gold, 1990; Gold *et al.*, 1993). Three SELEX procedures were performed to evolve high affinity ligands to IFN-gamma. Each SELEX procedure utilized

5   RNA pools containing pyrimidines modified at the 2' position as follows, 1) 2'F-CTP and 2'F-UTP referred to as 2'F, 2) 2'F-CTP and 2'NH$_2$-UTP referred to as 2'F/NH$_2$, and 3) 2'NH$_2$-CTP and 2'NH$_2$-UTP referred to as 2'NH$_2$. For each SELEX, the DNA template 40N7 was designed to contain 40 random nucleotides, flanked by 5' and 3' regions of fixed sequence (Table 1; SEQ ID NO:1). The fixed regions include DNA primer annealing sites

10   for PCR and cDNA synthesis as well as the consensus T7 promoter region to allow *in vitro* transcription.

Single-stranded DNA primers and templates were synthesized and amplified into double-stranded transcribable templates by PCR. Preparation of the initial pool of RNA molecules involved PCR amplification of 1000 pmoles of single-stranded template (Table

15   1; SEQ ID NO:1) and 2500 pmoles of both the 5'- (5P7; SEQ ID NO:2) and 3'- (3P7; SEQ ID NO:3) primers. These were incubated in a reaction mixture containing 50 mM KCl, 10 mM Tris-Cl (pH 8.3), 3 mM MgCl$_2$, 0.5 mM of each dATP, dCTP, dGTP, and dTTP. *Taq* DNA Polymerase (Perkin-Elmer, Foster City CA) at 0.1 U/μl was added and the reaction incubated at 97°C for 3 min to denature the template and primers. Following the initial

20   denaturing step, the reaction was cycled 10 times at 93°C for 30 sec, 53oC for 30 sec, and 72°C for 1 min to denature, anneal, and extend, respectively, the primers and template. To get an accurate concentration of double-stranded PCR product for the initial round of SELEX, the PCR product was purified using QIAquick-spin PCR purification columns (QIAGEN Inc., Chatsworth CA) as specified by the manufacturer.

25   For *in vitro* transcription using modified nucleotides 200 pmoles (final concentration of 1 μM) of double-stranded DNA template was incubated in a reaction mixture containing 40 mM Tris-Cl (pH 8.0), 12 mM MgCl$_2$, 5 mM DTT, 1 mM spermidine, 0.002% Triton X-100, 4% PEG 8000, 0.5 μM α-^{32}P-ATP, 5 U/μl T7 RNA Polymerase (Davanloo *et al.*, 1984), and concentrations of other nucleotides as follows, 1)

30   for the 2'F SELEX: 1 mM ATP and GTP, 3 mM 2'F-CTP and 2'F-UTP, 2) for the 2'F/NH$_2$ SELEX: 1 mM ATP, GTP, and 2'NH$_2$-UTP and 3 mM 2'F-CTP, and 3) for the

2'NH₂ SELEX: 1 mM ATP, GTP, 2'NH₂-CTP, and 2'NH₂-UTP. These incubations were performed in a 37°C incubator for between 6 hrs and overnight. Typically the RNA was purified by gel purification and elution. To expedite the process, for rounds 11, 12, and 14-17 the RNA was purified using Bio-Spin 6 chromatography columns (Bio-Rad

5   Laboratories, Hercules CA) according to manufacturer's specifications. To reduce background, the RNA was pre-filtered prior to all rounds of SELEX except rounds 1, 2, 4, 6, 14, and 16. The pre-filtration step involved bringing the RNA up to 200 μl in phosphate buffered saline (PBS), modified to contain 1mM Mg^{2+} ions, (138 mM NaCl, 2.7 mM KCl, 8.1 mM Na_2HPO_4, 1.1 mM KH_2PO_4, 1mM $MgCl_2$, pH 7.4), (mPBS), and passing this RNA

10   solution through three filter discs (0.45 μm, nitrocellulose/ cellulose acetate, Millipore Corporation, Bedford MA) pre-wetted with mPBS.

       For initial binding, 1000 pmoles of RNA were incubated with human IFN-gamma protein in binding buffer, (mPBS plus 0.01% human serum albumin (HSA)), for 5-10 min at 37°C to allow binding to occur. Human recombinant IFN-gamma used in this SELEX

15   procedure was purchased from two different sources. The first three rounds of both the 2'F and 2'F/NH₂ SELEX were performed with protein obtained from Upstate Biotechnology, Lake Placid NY. The subsequent rounds of these two SELEX procedures as well as the entire 2'NH₂ SELEX were performed with protein obtained from Genzyme Inc., Cambridge MA. For each round of SELEX the concentration of RNA and protein was

20   carefully chosen to provide optimum stringency. Increased stringency was obtained during rounds 8-13 of SELEX by adding NaCl to the binding buffer to bring the final chloride ion concentration up to 250 mM. Preliminary experiments had shown that IFN-gamma had a tendency to aggregate at high protein concentrations. To prevent the evolution of RNA species having an affinity for this aggregated IFN-gamma, beginning

25   with round 4 of SELEX and for all subsequent rounds of the SELEX procedure, the binding mix was centrifuged at 16,000 x g for 3 min in an eppendorf centrifuge before nitrocellulose filter partitioning. IFN-gamma/RNA complexes were separated from unbound RNA by nitrocellulose filter partitioning described below.

       For nitrocellulose partitioning, the 2'F and 2'F/NH₂ SELEX procedures used 0.2 μm

30   pore size pure nitrocellulose filters (Scleicher & Schuell, Keene NH) for the first two rounds of SELEX. All subsequent rounds of these two SELEX procedures and the entire

2'NH₂ SELEX were performed with 0.45 μm pore size nitrocellulose/cellulose acetate

mixed matrix filters (Millipore Corporation, Bedford MA). Filter discs were placed into a

vacuum manifold and wetted with 5 ml of mPBS buffer. The IFN-gamma/RNA binding

mix was aspirated through the filter discs which were immediately washed with 5 ml of

5   mPBS buffer. To further increase stringency and reduce background for rounds 8-13, and

15, this washing step was modified to include washing of the filter discs with 15 ml 0.5 M

urea followed by 20 ml mPBS buffer. Bound RNA was isolated from filters by extraction

in a solution of 400 m l phenol (equilibrated in Tris-Cl, pH 8.0)/300 m l 7 M urea (freshly

prepared). The filters were bathed in the phenol/urea solution at room temperature for 30

10   min and at 95°C for 2 min. The RNA was phenol/chloroform extracted and ethanol

precipitated with 20 mg tRNA.

The RNA was reverse transcribed into cDNA by addition of 50 pmoles DNA

primer, 0.4 mM each of dNTPs, and 1 U/μl AMV reverse transcriptase (AMV RT) (Life

Sciences, Inc., St. Petersburg FL) in buffer containing 50 mM Tris-Cl (pH 8.3), 60 mM

15   NaCl, 6 mM Mg(OAc)₂, 10 mM DTT. The reaction was incubated at 37°C for 30 min

then 48°C for 30 min then 70°C for 10 min, to ensure the melting of secondary structure

present in the isolated RNA.

To begin a new round of SELEX, the cDNA was PCR amplified by addition of 250

pmoles of both the 5' (5P7; SEQ ID NO:2) and 3' (3P7; SEQ ID NO:3) primer in reaction

20   conditions identical to those detailed above. The number of cycles of PCR required to

amplify the cDNA was carefully calculated for each round of SELEX so that 250 pmoles

double-stranded DNA template would be used to initiate the next round of SELEX.

C. Equilibrium Dissociation Constants (Kds)

25   The determination of equilibrium dissociation constants (Kds) for RNA pools was

made subsequent to rounds 5, 8, 12, and 17 to monitor the progress of each SELEX . The

Kds of RNA pools for mouse IFN-gamma (Genzyme Inc., Cambridge MA) were also

determined after rounds 8 and 17. Kds were determined for individual ligands after

cloning and sequencing of RNA pools and truncations (described below). Nitrocellulose

30   filter binding was used to determine Kds as follows: filter discs were placed into a

vacuum manifold and wetted with 5 ml of mPBS buffer. ³²P-labeled-RNA was incubated

with serial dilutions of IFN-gamma in binding buffer for 5-10 min at 37°C to allow

binding to occur. Binding mixes were centrifuged as described above to remove

aggregates, aspirated through the filter discs, and then immediately washed with 5 ml

mPBS buffer. The filter discs were dried and counted in a liquid scintillation counter

5   (Beckmann Instruments, Palo Alto CA). Equilibrium dissociation constants were

determined by least square fitting of the data points using the Kaleidagraph™ graphics

program (Synergy Software, Reading PA). Many ligands and evolved RNA pools yield

biphasic binding curves. Biphasic binding can be described as the binding of two affinity

species that are not in equilibrium. Biphasic binding constants were calculated according

10   to standard procedures. Kds were determined by least square fitting of the data points

using the Kaleidagraph™ graphics program.

D. Cloning and Sequencing

After the 17th round of SELEX, RNA molecules were reverse transcribed to cDNA

15   and made double-stranded by PCR amplification with primers containing recognition sites

for the restriction endonucleases *Hind* III (Table 1; 5' primer 5P7H; SEQ ID NO:4) and

Bam HI (Table 1; 3' primer 3P7B; SEQ ID NO:5). Using these restriction sites the DNA

sequences were inserted directionally into the pUC19 vector. These recombinant plasmids

were transformed into Epicurian coli JM109 competent cells (Stratagene, La Jolla CA).

20   Plasmid DNA was prepared with the PERFECTprep™ plasmid DNA kit (5 prime--->3

prime, Boulder CO). Plasmid clones were sequenced using a PCR sequencing protocol

(Adams *et al.*, 1991) using PCR sequencing primer pUC19F30 (SEQ ID NO:6).

E. Ligand Truncation

25   Boundary experiments were carried out to determine the minimal sequence

necessary for high affinity binding of the RNA ligands to IFN-gamma using end-labeled

RNA. Prior to end-labeling, RNA transcribed with T7 RNA polymerase was gel purified

by UV shadowing. The 5'-end of 20 pmoles of each RNA was dephosphorylated in a

reaction mixture containing 20 mM Tris-Cl (pH 8.0), 10 mM $MgCl_2$ and 0.1 U/μl shrimp

30   alkaline phosphatase (SAP), (United States Biochemical, Cleveland OH) by incubating for

30 min at 37°C. Alkaline phosphatase activity was destroyed by incubating for 30 min at

70°C. RNA was subsequently 5'-end labeled in a reaction mixture containing 50 mM

Tris-Cl (pH 7.5), 10 mM $MgCl_2$, 5 mM DTT, 0.1 mM EDTA, 0.1 mM spermidine, 0.75 m

M g-^{32}P-ATP and 1 U/µl T4 polynucleotide kinase (New England Biolabs, Beverly MA)

by incubating for 30 min at 37°C.

5   3'-end-labeling of 20 pmoles of each RNA was performed in a reaction mixture

containing 50 mM Tris-Cl (pH 7.8), 10 mM $MgCl_2$, 10 mM b-mercaptoethanol, 1 mM

ATP, 0.9 m M (5'-^{32}P)pCp and 1 U/µl T4 RNA ligase (New England Biolabs, Beverly

MA) by incubating for 18 hrs at 4°C. 5'- and 3'- end-labeled RNAs were gel band purified

on a 12%, 8M urea, polyacrylamide gel. After partial alkaline hydrolysis of the

10   end-labeled RNA by addition of Na_2CO_3 to a final concentration of 50 mM and incubation

in a boiling water bath for 3 min, radiolabeled RNA ligands were incubated with

IFN-gamma at three different protein concentrations, 1) 5-fold below the approximate Kd,

2) at the approximate Kd, and 3) 5-fold above the approximate Kd. Protein-bound RNA

was separated by nitrocellulose partitioning. RNA truncates were analyzed on a

15   high-resolution denaturing 12% polyacrylamide gel. To orient the sequences, a ladder of

radioactively labeled ligands terminating with G-residues was generated by RNase T1

digestion of end-labeled RNA. The T1 digest was carried out in a reaction mixture

containing 7 M urea, 20 mM sodium citrate (pH 5.0), 1 mM EDTA and 5 units RNase T1

(Boehringer Mannheim, Indianapolis IN) by incubating for 5 min at 50°C.

20   Complementary single-stranded DNA oligonucleotides containing the sequence of the

T7 promoter (5'-TAATACGACTCACTATAG-3'; fragment of SEQ ID NO:2) and the

sequence of the truncated ligand were annealed to form a double-stranded template for

transcription of each truncated ligand.

25   **F. Receptor Binding Competitions**

         Human lung carcinoma cells (A549; ATCC) were plated in 24-well plates at a

density of 5 X 10^5 cells/well in RPMI 1640 plus 10% fetal bovine serum (FBS) and

incubated overnight or until confluent. The cells were washed 3 times with PBS. Growth

media was replaced with 200 µl RPMI 1640 plus 0.2% human serum albumin/0.02%

30   sodium azide/20 mM Hepes, pH 7.4 together with increasing amounts (20 pg/ml-100

ng/ml) of ^{125}I-IFN-gamma (New England Nuclear) with or without an excess (200 fold) of

33

unlabeled IFN-gamma. Incubations were carried out at 4°C with shaking for 2 hrs. The

cells were washed 2 times with cold PBS to remove free IFN and detached with 0.5%

SDS. Cell-associated ^{125}I-IFN-gamma was determined by measuring the radioactivity of

the detached cells in a gamma counter. The data was corrected for nonspecific binding

5   and the affinity of ^{125}I-IFN-gamma was determined by Scatchard analysis of the binding

data. Scatchard analysis suggests that there are high-affinity binding sites (Kd = 20pM)

and low-affinity binding sites (Kd = 0.5nM). For competition with oligonucleotide, the

cells were incubated for 2 hr at 4°C as above with 30 pM ^{125}I-IFN-gamma and increasing

concentrations (1.01-500 nM) of competitor oligonucleotide. Cell-associated

10   ^{125}I-IFN-gamma was determined as above.

EXAMPLE 2.   2´-NH$_2$ AND 2´-F-MODIFIED RNA LIGANDS TO IFN-GAMMA

A. SELEX

Three libraries of RNAs modified at the 2' position of pyrimidines, 1) 2'F

15   incorporating 2'F-CTP and 2'F-UTP, 2) 2'F/NH$_2$ incorporating 2'F-CTP and 2'NH$_2$-UTP

and 3) 2'NH$_2$ incorporating 2'NH$_2$-CTP and 2'NH$_2$-UTP were used in simultaneous SELEX

protocols to generate a diverse set of high-affinity modified RNA ligands to human

IFN-gamma. Each of these libraries contained between 10^{13}-10^{14} molecules with a variable

region of 40 nucleotides The template and primers used for the SELEX and the

20   conditions of the SELEX, as described in Example 1, are summarized in Tables 1 and 2,

respectively.

B. RNA Sequences and Dissociation Constants

The random modified RNA pools bound human IFN-gamma with approximate

25   Kds of greater than 0.7 μM. After 17 rounds of SELEX, the approximate Kds of the

evolving pools had improved to, 1) 70 nM for the 2'F SELEX, 2) 115 nM for the 2'F/NH$_2$

SELEX, and 3) 20 nM for the 2'NH$_2$ SELEX. For mouse IFN-gamma, the approximate

Kds of the RNA pools after 17 rounds of SELEX were 1) 410 nM for the 2'F SELEX, 2)

175 nM for the 2'F/NH$_2$ SELEX, and 3) 85 nM for the 2'NH$_2$ SELEX. These Kds did not

30   shift further in subsequent rounds.

In order to determine to what extent the evolving pool was still random, PCR product from the final round of SELEX was sequenced as detailed above and found to be non-random. RNA from the 17th round was reverse transcribed, amplified and cloned. The sequences of 32 of the 2'F, 40 of the 2'NH$_2$, and 11 of the 2'F/NH$_2$ individual clones

5 were determined (Table 3; SEQ ID NOS:7-65). The sequences were analyzed for conserved sequences and aligned by this criterion (Table 3). The 2'F sequences fell in to 2 groups with 9 orphan sequences. Group 1 2'F RNAs were the most abundant, representing 18 of 32 sequences, while group 2 2'F RNAs represented 5 of 32 sequences. The 2'NH$_2$ sequences fell into 2 groups with 25 of 40 2'NH$_2$ RNAs in group 1 and 15 of 40 2'NH$_2$

10 RNAs in group 2. The 2'F/NH$_2$ sequences were of a single group.

The Kds of individual RNAs within each group were determined by nitrocellulose filter binding as described above. The Kds were determined using either a monophasic or biphasic least squares fit of the data.

Minimal sequence requirements for high-affinity binding of the best clones were

15 determined by 5' and 3' boundary experiments as described. The truncated RNAs were transcribed from double-stranded templates containing the T7 promoter and the truncated sequence. For those successful transcriptions, the Kd of the truncated ligand was determined. The sequence of the truncated ligands and their Kds, both for full-length and for the truncate (if determined) are shown in Table 4 (SEQ ID NOS:66-73).

20

C. Receptor Competition

Both full-length 2'NH$_2$ (2'NH$_{2\ random}$, 2'NH$_{2-17}$, 2'NH$_{2-30}$) and 2'F (2'F random, 2'F-1, and 2'F-28) oligonucleotides were tested for their ability to inhibit receptor binding. This competition was targeted primarily to the high-affinity binding component using a

25 concentration of ^{125}I-IFN-gamma of 30pM. At this concentration, neither the 2'NH$_2$ nor the 2'F random oligos showed inhibition, while varying degrees of inhibition were seen with the 4 clones tested. The 2'NH$_2$ ligand #30 (SEQ ID NO:72) was the best inhibitor and showed 50% inhibition at 10 nM.

EXAMPLE 3. EXPERIMENTAL PROCEDURES FOR 2′-NH₂ AND 2′-F-MODIFIED LIGANDS TO IL-4

This Example provides general procedures followed and incorporated in Example 4 for the evolution of nucleic acid ligands to IL-4.

A. Oligonucleotides

2'F modified CTP and UTP were prepared according to the method of Pieken *et al.*, 1991. 2'NH₂ modified CTP and UTP were prepared according to the method of McGee *et al.*, U.S. Patent Application No. 08/264,029, filed June 22, 1994, which is incorporated herein by reference (see also McGee *et al.* 1995). DNA oligonucleotides were synthesized by Operon Technologies (Alameda CA).

B. SELEX

The SELEX procedure has been described in detail in U.S. Patent No. 5,270,163 (see also Tuerk and Gold, 1990; Gold *et al.*, 1993). Three SELEX procedures were performed to evolve high affinity ligands to IL-4. Each SELEX procedure utilized RNA pools containing pyrimidines modified at the 2' position as follows, 1) 2'F-CTP and 2'F-UTP referred to as 2'F, 2) 2'F-CTP and 2'NH₂-UTP referred to as 2'F/NH₂, and 3) 2'NH₂-CTP and 2'NH₂-UTP referred to as 2'NH₂. For each SELEX, the DNA template 40N8 was designed to contain 40 random nucleotides, flanked by 5' and 3' regions of fixed sequence (Table 5; SEQ ID NO:74). The fixed regions include DNA primer annealing sites for PCR and cDNA synthesis as well as the consensus T7 promoter region to allow *in vitro* transcription.

Single-stranded DNA primers and templates were synthesized and amplified into double-stranded transcribable templates by PCR. Preparation of the initial pool of RNA molecules involved PCR amplification of 1000 pmoles of single-stranded template (Table 5; SEQ ID NO:74) and 2500 pmoles of both the 5' (5P8; SEQ ID NO:75) and 3' (3P8; SEQ ID NO:76) primers. These were incubated in a reaction mixture containing 50 mM KCl, 10 mM Tris-Cl (pH 8.3), 3 mM MgCl₂, 0.5 mM of each dATP, dCTP, dGTP, and dTTP. *Taq* DNA Polymerase (Perkin-Elmer, Foster City CA) at 0.1 U/μl was added and the reaction incubated at 97°C for 3 min to denature the template and primers. Following

the initial denaturing step, the reaction was cycled 7 times at 93°C for 30 sec, 53°C for 30
sec, and 72°C for 1 min to denature, anneal, and extend, respectively, the primers and
template. To get an accurate concentration of double-stranded PCR product for the initial
round of SELEX, the PCR product was purified using QIAquick-spin PCR purification
5   columns (QIAGEN Inc., Chatsworth CA) as specified by the manufacturer.

For *in vitro* transcription using modified nucleotides 200 pmoles (final
concentration of 1 μM) of double-stranded DNA template was incubated in a reaction
mixture containing 40 mM Tris-Cl (pH 8.0), 12 mM $MgCl_2$, 5 mM DTT, 1 mM
spermidine, 0.002% Triton X-100, 4% PEG 8000, 0.5 μM α-^{32}P 2'OH ATP, 5 U/μl T7
10 RNA Polymerase (Davanloo *et al.*, 1984), and concentrations of other nucleotides as
follows, 1) for the 2'F SELEX: 1 mM ATP and GTP, 3 mM 2'F-CTP and 2'F-UTP, 2) for
the 2'F/NH$_2$ SELEX: 1 mM ATP, GTP, and 2'NH$_2$-UTP and 3 mM 2'F-CTP, and 3) for
the 2'NH$_2$ SELEX: 1 mM ATP, GTP, 2'NH$_2$-CTP, and 2'NH$_2$-UTP. These incubations
were performed in a 37°C incubator for between 6 hrs and overnight. Typically the RNA
15 was purified by gel purification and elution. To expedite the process for rounds 11, 12,
and 14-17 the RNA was purified using Bio-Spin 6 chromatography columns (Bio-Rad
Laboratories, Hercules CA) according to manufacturer's specifications. To reduce
background, the RNA was pre-filtered prior to all rounds of SELEX except rounds 1, 2, 4,
6, 14, and 16. The pre-filtration step involved bringing the RNA up to 200 μl in phosphate
20 buffered saline (PBS), modified to contain 1 mM Mg^{2+} ions, (138 mM NaCl, 2.7 mM KCl,
8.1 mM Na_2HPO_4, 1.1 mM KH_2PO_4, 1mM $MgCl_2$, pH 7.4), (mPBS), and passing this RNA
solution through three filter discs (0.45 μm, nitrocellulose/ cellulose acetate, Millipore
Corporation, Bedford MA) pre-wetted with mPBS.

For initial binding, 1000 pmoles of RNA were incubated with human IL-4 protein
25 in binding buffer, (mPBS plus 0.01% human serum albumin (HSA)), for 5-10 min at 37
°C to allow binding to occur. Human recombinant IL-4 used in this SELEX procedure
was purchased from R & D Systems, Minneapolis MN. For each round of SELEX the
concentration of RNA and protein was carefully chosen to provide optimum stringency.
Preliminary experiments had shown that IL-4 had a tendency to aggregate at high protein
30 concentrations. To prevent the evolution of RNA species having an affinity for this
aggregated IL-4, beginning with round 4 of SELEX and for all subsequent rounds of the

SELEX procedure, the binding mix was centrifuged at 16,000 X g for 3 min in an

eppendorf centrifuge before nitrocellulose filter partitioning. IL-4/ RNA complexes were

separated from unbound RNA by nitrocellulose filter partitioning described below.

For nitrocellulose partitioning, the 2'F and 2'F/NH$_2$ SELEX procedures used 0.2 μm

5   pore size pure nitrocellulose filters (Scleicher & Schuell, Keene NH) for the first two

rounds of SELEX. All subsequent rounds of these two SELEX procedures and the entire

2'NH$_2$ SELEX were performed with 0.45 μm pore size nitrocellulose/cellulose acetate

mixed matrix filters (Millipore Corporation, Bedford MA). Filter discs were placed into a

vacuum manifold and wetted with 5 ml of mPBS buffer. The IL-4/RNA binding mix was

10   aspirated through the filter discs which were immediately washed with 5 ml of mPBS

buffer. To further increase stringency and reduce background for rounds 8-13, and 15, this

washing step was modified to include washing of the filter discs with 15 ml 0.5 M urea

followed by 20 ml mPBS buffer. Bound RNA was isolated from filters by extraction in a

solution of 400 μl phenol (equilibrated in Tris-Cl, pH 8.0)/ 300 μl 7 M urea (freshly

15   prepared). The filters were bathed in the phenol/urea solution at room temperature for 30

min and at 95°C for 2 min. The RNA was phenol/chloroform extracted and ethanol

precipitated with 20 μg tRNA.

The RNA was reverse transcribed into cDNA by addition of 50 pmoles DNA

primer, 0.4 mM each of dNTPs, and 1 U/μl AMV reverse transcriptase (AMV RT) (Life

20   Sciences, Inc., St. Petersburg FL) in buffer containing 50 mM Tris-Cl (pH 8.3), 60 mM

NaCl, 6 mM Mg(OAc)$_2$, 10 mM DTT. The reaction was incubated at 37°C for 30 min

then 48°C for 30 min then 70°C for 10 min, to ensure the melting of secondary structure

present in the isolated RNA.

To begin a new round of SELEX, the cDNA was PCR amplified by addition of 250

25   pmoles of both the 5' (5P8; SEQ ID NO:75) and 3' (3P8; SEQ ID NO:76) primer in

reaction conditions identical to those detailed above. The number of cycles of PCR

required to amplify the cDNA was carefully calculated for each round of SELEX so that

250 pmoles double-stranded DNA template would be used to initiate the next round of

SELEX.

30

C. Equilibrium Dissociation Constants (Kds)

The determination of equilibrium dissociation constants (Kds) for RNA pools was made subsequent to rounds 5, 8, 12, and 17 to monitor the progress of each SELEX. The Kds of RNA pools for mouse IL-4 (R & D Systems, Minneapolis MN) were also

5   determined after round 8. Kds were determined for individual ligands after cloning and sequencing of RNA pools and truncations (described below). Nitrocellulose filter binding was used to determine Kds as follows: filter discs were placed into a vacuum manifold and wetted with 5 ml of mPBS buffer. ^{32}P-labeled-RNA was incubated with serial dilutions of IL-4 in binding buffer for 5-10 min at 37°C to allow binding to occur.

10   Binding mixes were centrifuged as described above to remove aggregates, aspirated through the filter discs, and then immediately washed with 5 ml mPBS buffer. The filter discs were dried and counted in a liquid scintillation counter (Beckmann Instruments, Palo Alto CA). Equilibrium dissociation constants were determined by least square fitting of the data points using the Kaleidagraph™ graphics program (Synergy Software, Reading

15   PA). Many ligands and evolved RNA pools yield biphasic binding curves. Biphasic binding can be described as the binding of two affinity species that are not in equilibrium. Biphasic binding constants were calculated according to standard procedures. Kds were determined by least square fitting of the data points using the Kaleidagraph™ graphics program.

20

D. Cloning and Sequencing

After the 17th round of SELEX, RNA molecules were reverse transcribed to cDNA and made double-stranded by PCR amplification with primers containing recognition sites for the restriction endonucleases *Hind* III (Table 5; 5' primer 5P8H; SEQ ID NO:77) and

25   *Bam* HI (Table 5; 3' primer 3P8B; SEQ ID NO:78). Using these restriction sites the DNA sequences were inserted directionally into the pUC19 vector. These recombinant plasmids were transformed into Epicurian coli JM109 competent cells (Stratagene, La Jolla CA). Plasmid DNA was prepared with the PERFECTprep™ plasmid DNA kit (5 prime—>3 prime, Boulder CO). Plasmid clones were sequenced using a PCR sequencing protocol

30   (Adams *et al.*, 1991) using PCR sequencing primer pUC19F30 (SEQ ID NO:6).

E. Ligand Truncation

Boundary experiments were carried out to determine the minimal sequence necessary for high affinity binding of the RNA ligands to IL-4 using end-labeled RNA. Prior to end-labeling, RNA transcribed with T7 RNA polymerase was gel purified by UV

5   shadowing. The 5'-end of 20 pmoles of each RNA was dephosphorylated in a reaction mixture containing 20 mM Tris-Cl (pH 8.0), 10 mM $MgCl_2$ and 0.1 U/μl shrimp alkaline phosphatase (SAP), (United States Biochemical, Cleveland OH) by incubating for 30 min at 37°C. Alkaline phosphatase activity was destroyed by incubating for 30 min at 70°C. RNA was subsequently 5'-end labeled in a reaction mixture containing 50 mM Tris-Cl (pH

10   7.5), 10 mM $MgCl_2$, 5 mM DTT, 0.1 mM EDTA, 0.1 mM spermidine, 0.75 m M g -^{32}P-ATP and 1 U/μl T4 polynucleotide kinase (New England Biolabs, Beverly MA) by incubating for 30 min at 37°C.

3'-end-labeling of 20 pmoles of each RNA was performed in a reaction mixture containing 50 mM Tris-Cl (pH 7.8), 10 mM $MgCl_2$, 10 mM b -mercaptoethanol, 1 mM

15   ATP, 0.9 μM (5'-^{32}P)pCp and 1 U/μl T4 RNA ligase (New England Biolabs, Beverly MA) by incubating for 18 hrs at 4°C. 5'- and 3'- end-labeled RNAs were gel band purified on a 12%, 8M urea, polyacrylamide gel. After partial alkaline hydrolysis of the end-labeled RNA by addition of Na_2CO_3 to a final concentration of 50 mM and incubation in a boiling water bath for 3 min, radiolabeled RNA ligands were incubated with IL-4 at three different

20   protein concentrations, 1) 5-fold below the approximate Kd, 2) at the approximate Kd, and 3) 5-fold above the approximate Kd. Protein-bound RNA was separated by nitrocellulose partitioning. RNA truncates were analyzed on a high-resolution denaturing 12% polyacrylamide gel. To orient the sequences, a ladder of radioactively labeled ligands terminating with G-residues was generated by RNase T1 digestion of end-labeled RNA.

25   The T1 digest was carried out in a reaction mixture containing 7 M urea, 20 mM sodium citrate (pH 5.0), 1 mM EDTA and 5 units RNase T1 (Boehringer Mannheim, Indianapolis IN) by incubating for 5 min at 50°C.

Complementary single-stranded DNA oligonucleotides containing the sequence of the T7 promoter (5'-TAATACGACTCACTATAG-3'; fragment of SEQ ID NO:75) and the

30   sequence of the truncated ligand were annealed to form a double-stranded template for transcription of each truncated ligand.

F. Receptor Competition

Human T-cell lymphoma cells (H-9; ATCC) were cultured in suspension in RPMI
1640 + 10% FCS. Cells were washed two times with PBS and resuspended (5.0 x 10⁵
cells) in 200 μl media containing RPMI 1640 + 0.02% human serum albumin/0.2% Na
azide/20 mM HEPES, pH 7.4 for 2 hr at 4°C in 1.5 ml polypropylene tubes (Eppendorf,
W. Germany) with various amounts of ^{125}I-rIL-4 in the presence or absence of a 200-fold
excess of unlabeled cytokine. Following incubation, the tubes were spun (150 x g, 5 min,
4°C) and the supernatant was aspirated. The cell pellet was resuspended in 200 μl
RPMI-HSA. 100 μl aliquots were centrifuged through a cushion of an equal volume of
phthalate oils (dibutyl/dioctyl, 1:1 v/v). The tube was rapidly frozen in dry ice/ethanol and
the tip containing the cell pellet was cut off and placed in a vial for gamma counting. The
data was corrected for nonspecific binding and the affinity of ^{125}I-IL-4 was determined by
Scatchard analysis. For competition with oligonucleotide, or neutralizing antibody (R &
D Systems), the cells were incubated for 2 hr at 4° as above with 0.7 nM ^{125}I-IL-4 and
increasing concentrations (0.01-500 nM) of competitor oligonucleotide. Cell-associated
^{125}I-IL-4 was determined as above.

EXAMPLE 4. 2'-NH₂ AND 2'-F-MODIFIED RNA LIGANDS TO IL-4

     A. SELEX

Three libraries of RNAs modified at the 2' position of pyrimidines, 1) 2'F
incorporating 2'F-CTP and 2'F-UTP, 2) 2'F/NH₂ incorporating 2'F-CTP and 2'NH₂-UTP
and 3) 2'NH₂ incorporating 2'NH₂-CTP and 2'NH₂-UTP were used in simultaneous SELEX
protocols to generate a diverse set of high-affinity modified RNA ligands to human IL-4.
Each of these libraries contained between 10¹³-10¹⁴ molecules with a variable region of 40
nucleotides. The template and primers used for the SELEX and the conditions of the
SELEX, as described in Example 3 are summarized in Tables 5 and 6, respectively.

     B. RNA Sequences and Dissociation Constants

The random modified RNA pools bound human IL-4 with approximate Kds of
greater than 20 μM. After 17 rounds of SELEX, the approximate Kds of the evolving

41

pools had improved to, 1) 30 nM for the 2'F SELEX, and 2) 55 nM for the 2'F/NH$_2$

SELEX. Binding curves performed on 2'NH$_2$ RNA from an earlier round had shown an

approximate Kd of 100 nM, however, difficulties with background reduction in this

SELEX led to an apparent Kd after round 17 of 1 μM. It was felt that despite this

5   "masking" due to background, the high affinity unique sequence 2'NH$_2$ RNAs were still in

the pool after round 17. These Kds did not shift further in subsequent rounds. The RNA

pools after 8 rounds of SELEX did not bind mouse IL-4, while there was a significant

improvement in binding after 8 rounds for the human protein (data not shown).

In order to determine to what extent the evolving pool was still random, PCR

10   product from the final round of SELEX was sequenced as detailed above and found to be

non-random. RNA from the 17th round was reverse transcribed, amplified, and cloned.

The sequences of 41 of the 2'F, 57 of the 2'NH$_2$, and 30 of the 2'F/NH$_2$ individual clones

were determined (Table 7; SEQ ID NOS:79-177). The sequences were analyzed for

conserved sequences and aligned by this criterion (Table 7). The 2'F sequences fell into a

15   single group representing 29 of 41 sequences. The remaining 12 clones were categorized

as orphans due to their lack of sequence homology with the primary group or to each

other. The 2'NH$_2$ sequences fell into 2 distinct groups of sequences. Group 1 which

represented 21 of 57 sequences were shown to bind to IL-4. The other group, representing

35 of 57 sequences were shown to bind to nitrocellulose filters. The presence of such a

20   large number of nitrocellulose filter binding RNAs was not a surprise as these sequences

were cloned from a pool with high background binding. These nitrocellulose binding

RNAs are identified by the presence of a direct repeat of the sequence GGAGG. A single

orphan 2'NH$_2$ sequence was also found. The 2'F/NH$_2$ sequences were more heterogeneous

with sequences falling into 3 groups. RNAs in group 1 and 2 bound to IL-4, while the 3rd

25   group bound to nitrocellulose filters. The clones in the nitrocellulose filter binding group

also contained a single or repeat of the sequence GGAGG. It should be noted that this

sequence is also found in the 3'-fixed region (underlined in Table 7).

The Kds of individual RNAs within each group were determined by nitrocelulose

filter binding as described in Example 3 above. The Kds were determined using a

30   monophasic least squares fit of the data.

Minimal sequence requirements for high-affinity binding of the best clones were

determined by 5' and 3' boundary experiments as described in Example 3. The truncated

RNAs were transcribed from double-stranded templates containing the T7 promoter and

the truncated sequence. For those successful transcriptions, the Kd of the truncated ligand

5   was determined. The sequence of the truncated ligands and their Kds, both for full-length

and for the truncate (if determined) are shown in Table 8 (SEQ ID NOS:178-185).

C. Receptor Competition

Full-length 2'NH$_2$ (2'NH$_2$ random, 2'NH$_2$-29), 2'F (2'F random, 2'F-9) and 2'F/NH$_2$

10 (2'F/NH$_2$ random, 2'F/NH$_2$-9 and 2'F/NH$_2$-28) oligonucleotides were tested for their ability

to inhibit receptor binding. Neither the 2'NH$_2$, 2'F, or 2'F/NH$_2$ random oligos showed

inhibition, while varying degrees of inhibition was seen with the clones tested. At an IL-4

concentration of 0.7 nM the 2'F/NH$_2$ ligand-9 was the best competitor for receptor binding

and showed 50% inhibition at approximately 40 nM. The competition by this

15 oligonucleotide was similar to that seen by a neutralizing antibody to IL-4.

EXAMPLE 5. EXPERIMENTAL PROCEDURES FOR 2'-F MODIFIED LIGANDS TO IL-10

This Example provides general procedures followed and incorporated in Example

20 6 for the evolution of nucleic acid ligands to IL-10.

A. Materials

DNA sequences were synthesized by using cyanoethyl phosphoramidite under

standard solid phase chemistry. 2'-F CTP and 2'-F UTP were purchased from United

25 States Biochemicals. Human IL-10 was bought from either Bachem or R&D Systems.

Neutralizing anti-human IL-10 monoclonal antibody, murine IL-10 and ELISA detection

kit for human IL-10 were purchased from R &D Systems.

B. SELEX

30   Five nmoles of synthetic DNA template, that was purified on an 8%

polyacrylamide gel under denaturing conditions were amplified by four cycles of

polymerase chain reaction (PCR). The PCR products were transcribed *in vitro* by T7

RNA polymerase (1000 U) in 1 mL reaction consisting of 2 mM each of ATP and GTP, 3

mM each of 2'-F CTP and 2'-F UTP, 40 mM Tris-HCl (pH 8.0), 12 mM $MgCl_2$, 1 mM

Spermidine, 5 mM DTT, 0.002% Triton X-100 and 4% polyethelene glycol (w/v) for 10 -

5   12 hr. The full-length transcription products (SEQ ID NO:186) were purified on 8%

denaturing polyacrylamide gels, suspended in TBS buffer [100 mM Tris-HCl, (pH 7.5)

150 mM NaCl) (binding buffer), heated to 70 °C, chilled on ice, then incubated with IL-10

at 37 °C for 10 min. The RNA-protein mixture was filtered through a pre-wet

nitrocellulose filter then washed with 5 mL of the binding buffer. Bound RNAs were

10   eluted from the filter and recovered by ethanol precipitation. The RNA was reverse

transcribed by avian myeloblastosis virus reverse transcriptase (Life Sciences) at 48 °C for

45 min with 5'-GCCTGTTGTGAGCCTCCTGTCGAA-3' primer (Table 9; SEQ ID

NO:188). The cDNA was amplified by PCR (with 5' and 3' primers (SEQ ID

NOS:187-188)) and the resulting DNA template was transcribed to obtain RNA for the

15   next round of selection. During the course of SELEX, the concentration of IL-10 was

decreased gradually from 5 μM to 500 nM to progressively increase selective pressure.

The selection process was repeated until the affinity of the enriched RNA pool for IL-10

was substantially increased. At that point, cDNA was amplified by PCR with primers that

introduced BamH1 and Hind III restriction sites at 5' and 3' ends, respectively. PCR

20   products were digested with *BamHI* and *Hind III* and cloned into pUC 18 that was

digested with the same enzymes. Individual clones were screened and sequenced by

standard techniques.

C. Determination of equilibrium dissociation constants (K_d).

25   Internally-labeled RNA transcripts were prepared by including [α-^{32}P]ATP in T7

RNA polymerase transcription reactions. Full-length transcripts were purified on 8%

denaturing polyacrylamide gels to ensure size homogeneity. Gel-purified RNA was

diluted to a concentration of ~ 5 nM in TEM buffer, heated to 80 °C then chilled on ice to

facilitate secondary structure formation. RNA concentrations were kept lower than 100

30   pM in binding reactions. Briefly, equal amounts of RNA were incubated with varying

amounts of IL-10 in 50 μL of TEM buffer for 10 min at 37 °C. RNA-protein mixtures

were passed through pre-wet nitrocellulose filters (0.2 μ) and the filters were immediately

washed with 5 mL of binding buffer. Radioactivity retained on filters was determined by

liquid scintillation counting. The quantities of RNA bound to filters in the absence of

protein was determined and used for background correction. The percentage of input RNA

5   retained on each filter was plotted against the corresponding log protein concentration. The

nonlinear least square method to obtain the dissociation constant (K_d).

D. Sandwich ELISA

Sandwich ELISA was carried out by using commercially available ELISA kit for

10   quantitative determination of hIL-10 (from R&D systems) according to manufacturer's

instructions. Varying amounts of RNA 43, random pool RNA and anti-hIL-10

monoclonal antibody (from R&D Systems) were incubated with 125 pg/mL hIL-10 at

room temperature for 10 min before added to microtiter wells.

15   **EXAMPLE 6. 2´-F-MODIFIED RNA LIGANDS TO IL-10**

Under nitrocellulose filter binding conditions the random sequence pool that was

used to initiate the SELEX experiment did not show detectable binding to IL-10 as high as

5 μM concentration. However, after twelve rounds of affinity selection the enriched pool

exhibited improved affinity, and further selection beyond the 12th round had no effect on

20   increasing the affinity for IL-10. Table 10 (SEQ ID NOS:189-205) shows the sequences

identified from the 12th round pool. Sequences are grouped into three classes based on the

sequence similarity. The 5' part in the variable 40 nucleotide region of most sequences in

class I has sequence complementarity to the 3' part, suggesting that such sequences can

fold into a stemloop structure.

25   Individual clones were initially screened for their ability to bind IL-10 at 250 nM

concentration. The results show that 20-40% of input individual RNAs was bound to IL-10

at 250 nM. Based on preliminary screening, sequence 43 (SEQ ID NO:189) was chosen as

a representative ligand to carry out in section B below.

The Kd of sequence 43 for binding to IL-10 is 213 nM. The ligand 43, on the

30   other hand does not bind to other cytokines such as interferon g and IL-4, indicating the

specificity of SELEX-derived RNA sequence. Human IL-10 (hIL-10) and mouse IL-10

(mIL-10) have high degree of sequence homology at the cDNA and amino acid level (73%
amino acid homology) and hIL-10 has been shown to active on mouse cells. However,
ligand 43 does not bind to mIL-10 with high affinity.

5   **B. RNA in IL-10 ELISA**

         An anti-IL10 monoclonal antibody that neutralizes the receptor binding is
commercially available. The R&D systems' Quantikine Immunoassay kit is based on 96
well microtiter plates coated with the neutralizing antibody to capture hIL-10. The ELISA
was used to investigate whether RNA binds at or near the neutralizing antibody binding
10   site on IL-10. RNA 43, similar to the random pool RNA (used as a control) did not show
any inhibition of IL-10 binding to anti-IL-10 antibody on the plate (data not shown).
These data suggest that the evolved RNA ligand does not bind to the site at or near that
recognized by the neutralizing antibody. The soluble anti-IL10 that was used in the assay
as a control behaved as expected, competing for binding with the same antibody on the
15   solid phase.

         EXAMPLE 7. EXPERIMENTAL PROCEDURES FOR LIGANDS TO hTNFα

         This Example provides general procedures followed and incorporated in Examples
8-11 for the evolution of nucleic acid ligands to hTNFα.

20

         A. Materials

         Recombinant human TNFα (hTNFα) was purchased from Genzyme (Cambridge,
MA) or R&D Systems (Minneapolis, MN), recombinant murine TNFα (mTNFα),
recombinant human TNFß (hTNFß), and soluble human TNF receptor 2 (sTNF-R2) were
25   purchased from R&D Systems. Acetylated, and nuclease free bovine serum albumin
(BSA), ligase and restriction enzymes were from new England Biolabs (Beverly, MA).
AMV resverse transcriptased were from Life Sciences (St. Petersburg, FL). RNasin
ribonuclease inhibitor, and Taq DNA polymerase was from Promega (Madison, WI).
Ultrapure nucleotide triphosphates were from Pharmacia (Piscataway, NJ). ^{125}-I-TNFα,
30   α-^{32}P-ATP, and γ-^{32}P-ATP were from DuPont NEN Research Products (Boston, MA).
U937 cells were from ATCC (catalog number CRL1593). Oligonucleotides were obtained

from Operon, Inc. (Alameda, CA). Nitrocellulose/cellulose acetate mixed matrix (HA),

0.45 μm filters were from Millipore (Bedford, MA). Chemicals were at least reagent grade

and purchased from commercial sources.

5   **B) SELEX**

The SELEX procedure has been described in the SELEX Patent Application (see

also Tuerk and Gold, 1990; Gold *et al.*, 1993). The starting RNA contained 30 random

nucleotides, flanked by 5' and 3' constant regions for primer anealing sites for cDNA

synthesis and PCR amplification (Table 11; SEQ ID NO:206). The single stranded DNA

10   molecules were converted to double stranded by PCR amplification. PCR conditions were

50 mM KCl, 10 mM Tris-HCl, pH9, 0.1% Triton X-100, 3 mM $MgCl_2$, 0.5 mM of each

dATP, dCTP, dGTP, and dTTP, 0.1 units/μl Taq DNA polymerase and 1 nM each of the 5'

and 3' primers. Transcription reactions were done with about 5μM DNA template, 5

units/μl T7 RNA polymerase, 40 mM Tris-HCl (pH8), 12 mM $MgCl_2$, 5 mM DTT, 1 mM

15   spermidine, 0.002% Triton X-100, 4% PEG 8000, 2-4 mM each 2'OH NTP, and 0.25 μM

a-^{32}P-ATP (800 Ci/mmole). For 2'F modified transcripts, 2'F-CTP and 2'F-UTP were used

instead of 2'OH-CTP and 2'OH-UTP. Two different SELEX experiments were done. In

the first SELEX experiment, SELEX-A, the protein was immobilized onto nitrocellulose

filters and the RNA ligands were partitioned by capture to the immobilized protein.

20   Briefly, hTNFα was spotted on a nitrocellulose filter (Millipore, HA 0.45 μm) and

following 5 min air drying over filter paper, the nitrocellulose filter was incubated in a

24-well microtiter plate with 1-2x10^{-6} M radiolabeled RNA for 30 min at room

temperature in 500 μl binding buffer (BB=10 mM Tris-HCl, pH 7.5, 150 mM NaCl, 1 mM

EDTA, 0.02% acetylated BSA, 0.02% ficol, and 0.02% PVP). The filter was then washed

25   three times for 10 minutes each in 1.5 ml BB without BSA. Binding and washing was

done under rigorous agitation. The RNA bound to the immobilized protein was recovered

by phenol/urea extraction and was then reverse transcribed into cDNA by AMV reverse

transcriptase at 48°C for 60 min in 50 mM Tris-HCl pH8.3, 60 mM NaCl, 6 mM

Mg(OAc)$_2$, 10 mM DTT, 50 pmol DNA primer-1 (Table 11; SEQ ID NOS:206-208), 0.4

30   mM each of dATP, dCTP, dGTP, and dTTP, and 1 unit/μl AMV RT. The cDNA was then

PCR amplified and used to initiate the next SELEX cycle as described above. In the

second SELEX experiment, SELEX-B, the binding buffer was Dulbecco's

Phosphate-Buffered Saline (DPBS) with calcium and magnesium (Life Technologies,

Gaithersburg, MD, Cat. No 21300-025) and the protein-RNA complexes were partitioned

by filtering through nitrocellulose/cellulose acetated mixed matrix, 0.45 μm pore size filter

5   disks (Millipore, Co., Bedford, MA). Nitrocellulose filter bound RNA was recovered by

phenol/urea extraction. The partitioned RNA was then reverse transcribed and PCR

amplified as above and used to initiate the next SELEX cycle.

C. Determination of Equilibrium Dissociation Constants

10   To partition the protein-RNA complexes, the binding reactions were filtered

through nitrocellulose/cellulose acetated mixed matrix, 0.45 μm pore size filter disks

(Millipore, Co., Bedford, MA). For filtration, the filters were placed onto a vacuum

manifold and wetted by aspirating 5 ml of DPBS. The binding reactions were aspirated

throught the filters and following a 5 ml wash, the filters were counted in a scintillation

15   counter (Beckmann). Nitrocellulose partitionsing was used for SELEX and for

determining the equilibrium dissociation constants of RNA ligands to TNFα. RNA

ligands to TNFα bind monophasically.

           To obtain the equilibrium dissociation constants of RNA ligands to TNFα the

binding reaction:

20   K_D

              $R:P \rightleftharpoons R+P$

              R=RNA

              P=Protein

              K_D=dissociation constant

25
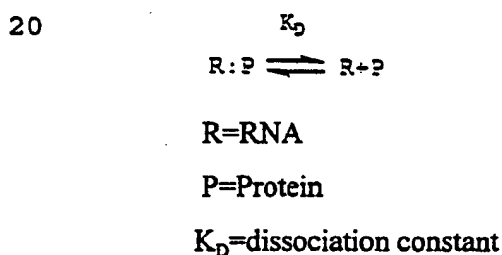
       is converted into an equation for the fraction of RNA bound at equilibrium:

$$q=(f/2R_T)(P_T+R_T+K_D-((P_T+R_T+K_D)^2-4P_TR_T)^{1/2})$$

30   q=fraction of RNA bound

              P_T=total protein concentration

48

R_T=total RNA concentration

f=retention efficiency of RNA-protein complexes

The average retention efficiency for RNA-TNFα complexes on nitrocellulose filters is

5   0.1-0.2.

The K_Ds were determined by least square fitting of the data points using the

software Kaleidagraph (Synergy Software, Reading, PA).

D. Cloning and Sequencing

10   RT-PCR amplified cDNA from the last round of SELEX was cloned between

BamHI and HindIII restriction sites of pUC18 plasmid (Vieira et al., 1982, Gene 19:

259-268) in MC1061 E. coli (Casadaban et al., 1980, J Mol Biol 138: 179-207).

Sequencing was done using PCR products as templates with a commerically available kit

(Promega, Madison WI).

15

E. Receptor Binding Competition Assay

A receptor binding competition assay was used to determine the bioactivity of the

RNA ligands. [125]I labelled hTNFα at 0.1 nM was incubated in 50 μl of binding medium

(PBS with 0.5 mM Mg^{++}, 0.2% BSA, 0.02% sodium azide, 1U/μl RNasin) for 15 min at

20   4°C with serially diluted competitors at 10^{-4} to 10^{-11} M, and $1 \times 10^4/\mu$l U937 cells.

Duplicate aliquots were subsequently removed, centrifuged through 2:1

dibutyl-phthalate:dinonyl-phthalate mixture to separate free and bound ^{125}I labelled

hTNFα, and the radioactivity in the pellet was measured on a gamma counter.

Nonspecific binding was determined by inclusion of a 200-fold molar excess of unlabeled

25   TNF.

The inhibition constants (Ki) of the RNA ligands were determined by a nonlinear

regression analysis of the data using standard techniques. To obtain Ki values the

concentration of TNF receptor was assumed to be 3.4×10^{-11} M and the K_D of the

TNFα-TNFR interaction of 0.1 nM.

F. Boundary determination

For 3' boundary determination, the 6A RNA ligand was 5' end labeled with γ -^{32}P-ATP using T4 polynucleotide kinase. 5' boundaries were established using 3' end labeled ligand with α-^{32}P-pCp and T4 RNA ligase. After partial alkaline hydrolysis, the radiolabeled RNA ligand was incubated with hTNFα at 5, 25, and 125 nM, and the protein bound RNA was isolated by nitrocellulose partitioning. The RNA truncates were analyzed on a high resolution denaturing polyacrylamide gel. An alkaline hydrolysis ladder and a ladder of radioactively labeled ligands terminated with G-residues, generated by partial RNase T1 digestion, were used as markers.

EXAMPLE 8. RNA LIGANDS TO hTNFα

A. pre-SELEX characterization

Nitrocellulose filter binding could not detect any interaction of hTNFα with random RNA even at high protein concentrations. The binding curves were completely flat even up to 10μM hTNFα and RNA up to 1μM and the estimated dissociation constant (K_D) is greater than 10^{-3} M. No buffer conditions were found that improved the interaction of hTNFα and random RNA.

To determine whether hTNFα was binding any RNA at all we used a more sensitive technique similar to northwestern probing (Bowen *et al.*, 1980). This technique was used in various studies of protein nucleic acid interaction and aided in the cloning of various DNA binding proteins (Singh *et al.*, 1988). This experiment showed clearly that some random RNA can bind to hTNFα. RNA binding occurred only when the filter was previously spotted with hTNFα and and then dried, but not if the filter was spotted with hTNFα and then placed wet in the incubation chamber. The RNA was binding only on the filters carrying hTNFα but not on filters carrying BSA possibly because, either not enough BSA was immobilized on the filter or the BSA present in the incubation mix was competing for available BSA-specific RNA ligands.

B. SELEX.

Two independent SELEX experiments (A and B) were initiated with pools of randomized RNA containing about 10^{14} unique molecules. The starting RNA and the PCR primer sequences are shown in Table 11.

5   In the A-SELEX, the protein was immobilized on a nitrocellulose filter by drying. The protein containing filter was incubated in BB (see Example 7) with labeled RNA, then washed, autoradiographed and the bound RNA was recovered by phenol-urea extraction. For the first round of A-SELEX about 1,000 pmoles of hTNFα monomer was used and the RNA concentration was at $2x10^{-6}$M. For the subsequent 14 rounds, two different filters

10   containing about 500 and 100 pmoles of hTNFα monomer were incubated in the same chamber containing amplified RNA from the previous round at about $2x10^{-6}$M. Only the RNA from the high protein filter was carried to the next round. A steady increase in the signal to noise ratio was observed and at round 15 the signal retained on the 500- and 100-pmole protein filters was 170- and 35-fold above background respectively. For

15   comparison, in the first round the signal was only about 3-fold above background. RNA from round 15 had a higher affinity for hTNFα with an estimated Kd of $5x10^{-5}$ M, representing a possible 100 fold improvement over the random RNA. To increase the stringency of the selection, we carried 8 more rounds using filters with about 10 and 1 pmole of hTNFα. For all these subsequent rounds, except for round 20, the RNA from the

20   1 pmole hTNFα filters was carried to the next round. Because of high background, at round 20 we used the RNA from the 10 pmoles hTNFα filter of round 19. The signal to noise ratio for these subsequent rounds became worse at each round but nevertheless the affinity of the evolved RNA continued to improve with estimated final Kd of $7x10^{-7}$ M, which represents two additional orders of magnitude improvement. In the final round, we

25   could detect signal with 10-fold shorter exposure time was detected, and with 100 - fold less hTNFα on the filter.

        In parallel with the stringent phase of A-SELEX, RNA from round 15 of the A-SELEX was evolved using B-SELEX conditions (see below) for 6 more rounds. We designated this as C-SELEX. The affinity of the evolved population at the end of

30   C-SELEX was similar to the round 23 population of A-SELEX with approximate Kd=$4x10^{-7}$ M.

The evolved RNA from round 23 had not only improved affinity for hTNFα but it was also specific (Table 13). Binding could be detected only with hTNFα.

In the B- SELEX experiment, binding reactions were set in 25-50μl and after 10 min incubation at 37°C it was filtered through a 0.45 μm HA nitrocellulose filter. For the

5   first round of the B-SELEX, the RNA and protein were at about 4×10^{-5} M each. Under these conditions only 0.1% of the input RNA was retained on the filter. This was not surprising since the hTNFα-random-RNA interaction is very weak with a Kd too high to measure and probably in the 10^{-3} M range. Subsequent rounds were set similar to the first round. By round 8, the background binding of the RNA to the nitrocellulose filters was

10   very high.

C. RNA sequences and Affinitites

RT-PCR amplified cDNA from round 23 of A-SELEX and round 6 of C-SELEX were cloned and sequenced as described in Example 7. 37 clones were sequenced from

15   A-SELEX and 36 cloned from C-SELEX. From the total of 73 sequences, 48 were unique (Table 12; SEQ ID NOS:209-255). A unique sequence is defined as one that differs from all others by three or more nucleotides. Of the 47 unique clones, 18 clones could bind to hTNFα with Kd better than 1 μM (Table 12). The best ligand, 25A, (SEQ ID NO:233) binds with affinity dissociation constant at about 40 nM. If it is assumed that the random

20   RNA binds with a dissociation constant of greater than 10^{-3} M, then the affinity of 25A is at least four to five orders of magnitude better than the starting pool.

Using sequence alignment and conserved predicted secondary structure, 17 out of 18 clones that bind hTNFα could be assigned into two classes.

The members of the class II can be folded in stem-loop structures with internal

25   bulges and asymmetric loops. Linear sequence alignment did not reveal any significant conserved sequences.

D. Specificity of RNA Ligands to TNF

We tested the specificity of the evolved pool of round 23 of A-SELEX against

30   human TNFα, human TNFβ and murine TNFα. The evolved pool is highly specific for human TNFα and specificity ratios are shown in Table 13.

52

EXAMPLE 9. Inhibition of hTNFα Binding to Cell Surface receptors

To test the ability of the TNFα ligands to competitively inhibit the binding of hTNFα to its cell surface receptor, the U937 cells were used to screen several hTNFα

5 ligands. The observed Kis are listed in Table 14. The data show that several ligands can competitively inhibit binding of hTNFα to its cell surface receptors while random RNA cannot. Ligand 25A has the highest potency with a Ki of 21 nM. This Ki value is only 6 fold worse than the Ki observed with the sTNF-R2 under the same experimental conditions.

10

EXAMPLE 10. <u>Effect of 2'F Pyrimidine Modification on the Binding and Inhibitory Activities of the hTNFα Ligands</u>

Transcripts containing 2'F modified pyrimidines are resistant to RNase degradation. To obtain ligands with improved stability we tested the effect of 2'F

15 pyrimidine modification on the binding and inhibitory activity of several hTNFα ligands. The results summarized in Table 15 show that some of the ligands retained binding activity when are modified with 2'F pyrimidines but in general the modified ligands bind worse than the unmodified counterparts. Class II ligands are in general more tolerant of the 2'F pyrimidine modification. Most of the ligands that retained binding after the 2'F

20 pyrimidine modification lose their inhibitory activity. Only the 2'F pyrimidine modification of the most abundant ligand, 6A, did not affect its binding and inhibitory activities.

EXAMPLE 11: <u>Experimental Procedures for DNA Ligands to RANTES</u>

25 This example provides general procedures followed and incorporated in Example 12 for the evolution of nucleic acid ligands to RANTES.

A. Materials

Recombinant human RANTES was purchased from Genzyme (Cambridge, MA).

30 Taq DNA polymerase was Perkin Elmer (Norwalk, CT). T4 polynucleotide kinase was purchased from New England Biolabs (Beverly, MA). Ultrapure nucleotide triphosphates

were purchased form Pharmacia (Piscataway, NJ). Affinity purified streptavidin (Cat. No

21122) was from Pierce (Rockford, IL). Oligonucleotides were obtained from Operon,

Inc. (Alameda, CA). Nitrocellulose/cellulose acetate mixed matrix (HA), 0.45 μm filters

were purchased form Millipore (Bedford, MA). Chemicals were at least reagent grade and

5   purchased from commercial sources.

B.   SELEX

The SELEX procedure has been described in detail in the SELEX Patent

Applications. The DNA template contained 40 random nucleotides, flanked by 5' and 3'

10   constant regions for primer anealing sites for PCR (Table 16; SEQ ID NOS:256-258).

Primer 3G7 (SEQ ID NO:258) has 4 biotin residues in its 5' end to aid in the purification

of single stranded DNA (ssDNA). For the first round, 105 pmoles of synthetic 40N7

ssDNA were 5' end labelled using T4 polynucleotide kinase in a 25 μl reaction containing

70 mM Tris-HCl pH 7.6, 10 mM $MgCl_2$, 5 mM DTT, 39.5 pmoles of g -^{32}P-ATP (3000

15   Ci/mmol), and 16 units kinase, for 1 h at 37°C. The kinased DNA was then purified on an

8% polyacrilamide, 7M urea, denaturing gel and then mixed with gel purified unlabeled

40N7 to achieve about 5,000 cpm/pmol specific activity. To prepare binding reactions, the

DNA molecules were incubated with recombinant RANTES in Hanks' Balanced Salt

Solution (HBSS) without calcium and magnesium (Life Technologies, Gaithersburg, MD,

20   Cat. No 14175) containing 0.01% human serum albumin. Two SELEX experiments were

performed, one with normal salt concentration and the other with 300 mM NaCl. The high

salt concentration was achieved by adding additional NaCl to the HBSS. Following

incubation at room temperature for 30 minutes the protein-DNA complexes were

partitioned from unbound DNA by filtering through HA nitrocellulose 0.45 μm.

25   Nitrocellulose filter bound DNA was recovered by phenol/urea extraction. The partitioned

DNA was PCR amplified in 50 mM KCl, 10mM Tris-HCl, pH9, 0.1% Triton X-100, 3mM

$MgCl_2$, 1 mM of each dATP, dCTP, dGTP, and dTTP, with 0.1 units/μl Taq DNA

polymerase. The 3G7 and 5G7 primers were present at 2 μM. The 5G7 primer was 5'-end

labeled before use described above. To purify ssDNA, the PCR product was ethanol

30   precipitated and then reacted with affinity purified streptavidin at a molar ratio 1:10 DNA

to streptavidin in 10 mM Tris-HCl pH 7.5, 50 mM NaCl, 1 mM EDTA, 0.05% sodium

azide. Following 30 incubation at room temperature, equal volume of 100% formamide

tracking dye was added and the strands were denatured by incubating at 85°C for 1.5 min.

The denatured strands were then electophoresed in an 8% polyacrylamide, 7M urea gel

and the nonshifted band was excised and purified from the crushed gel. The purified

5   ssDNA was then used for the next SELEX cycle.

EXAMPLE 12: DNA LIGANDS TO RANTES

A. SELEX

10   To generate DNA ligands for RANTES, two SELEX experiments were performed,

one with 150 mM and the other with 300 mM NaCl. The high salt was used in order to

avoid precipitation of the RANTES-DNA complexes that occurs at the lower salt

concentration. The SELEX at 300 mM salt was prematurely terminated because of high

background. The SELEX conditions and results for each round of the 150 mM salt

15   SELEX are summarized in Table 17. The starting pool contained 1.8×10^{15} (2,940 pmoles)

of DNA for the 150 mM salt SELEX. The starting KD values of the random DNA were

3×10^{-6} M. After 19 rounds of SELEX the evolved pools bound with a K_D of 20 nM. This

represents about 150 fold improvement.

Table 1

40N7 TEMPLATES AND PRIMERS

	SEQ ID NO.

40N7 ssDNA Template:
5' GGGAGGACGAUGCGG [-40N-] CAGACGACUCGCCCGA 3'   1

SELEX PCR Primers:
5P7:
5' TAATACGACTCACTATAGGGAGGACGATGCGG 3'   2
3P7:
5' TCGGGCGAGTCGTCTG 3'   3

Cloning PCR Primers:
5P7H:
       Hind III
5' CCGAAGCTTAATACGACTCACTATAGGGAGGACGATGCGG 3'   4
3P7B:
       Bam HI
5' GCCGGATCCTCGGGCGAGTCGTCTG 3'   5

PCR Sequencing Primer:
pUC19F30:
5' AGTCACGACGTTGTAAAACGACGGCCAGTG 3'   6

Table 2

SELEX STRATEGY

	IFN-gamma					
Round	[Protein]	RNA:Protein	RNA Pre-filtration	Stringent Wash	NaCl 250mM	Bio-spin purified RNAs
1	10^{-6}	5				
2	10^{-6}	2.5				
3	10^{-6}	1.5	X			
4	10^{-6}	1				
5	5×10^{-7}	1	X			
6	2.5×10^{-7}	1				
7	10^{-7}	1	X			
8	10^{-7}	1	X	X	X	
9	10^{-7}	1	X	X	X	
10	10^{-7}	1	X	X	X	
11	10^{-7}	1.5	X	X	X	X
12	10^{-7}	1.5	X	X	X	X
13	10^{-7}	1.5	X	X		
14	2×10^{-8}	5				X
15	10^{-8}	5	X	X		X
16	2×10^{-9}	5				X
17	10^{-9}	5	X			X

Table 3

a) IFN-gamma 2'F Sequences

5'-GGGAGGACGAUGCGG(40N)CAGACGACUCGCCCGA-3'

40N

GROUP 1 (18 clones)

SEQ ID NO.		
#1,2,5,11,12,15,18,21,26,32,35	ACACCGUUAAUCUGAGGCCCUGUCCUAUUCCUUCACGCCU	1
#3	ACACCGUUAGUCUGAGGCCUUGUCCUAUUCCUUCACGCCU	7
#10	ACACCUUUAAUCUGAGGCCCUGUCCUAUUCCUUCACGCCU	8
#22	ACACCUUGAAUCUGAGGCCCUGUCCUAUUCCUUCACGCCU	9
#29	ACACCGUUAAUCUGAGGCCCUGUCCUAUUCCUUCACGCCU	10
#31	ACACCGUAGAUCUGAGGCCCUGUCCUAUUCCUUCACGCCU	11
#19	ACACCGUUAAUCUGAGGCCCUGUCC AUUCCUUCACGCCU	12
#13	ACACCGUUAAACUGAGGCCCUGUCCUAUUCCUUCACGCCU	13
		14

GROUP 2 (5 clones)

SEQ ID NO.		
#27	AACACCCCCGGUCUGACGCUUGUCCGAAUUCCUCCACCGU	15
#8	GAACACCCCGGUCUGACGCUUGUCCGAAUUCCUCCACCGU	16
#33	AACACC CCGGUCUGACGCUUGUCCGAAUUCCUCCACCGU	17
#34	AACACCCCCGGUUUGACGCUUGUCCGAAAUCCUCCACCGU	18
#36	AACACCCCCGGUCUGACGCUUGUUCCG AAUCCUCCACCGU	19

SEQ ID
NO.

Table 3 (Page 2)

ORPHANS (9 clones)

		SEQ ID NO.
#4	GGUUCCUGUUCUACUUUCUAAUUAUCCGCACCUCCUCCU	20
#6	UGGAGUUUAAUCUUACUUCCUACUCUCUGCUCCACUGGGU	21
#7	GAUUCAUUUGAUCUUUCUUCUCUUUCUCUUAUCCCGCUGUGCCU	22
#23	AUUCCCUUUCCUUUCUCUUUUGACCGACUGAUCCGCCU	23
#25	UAAUCUACACUAUAAUUUUUUCUUUUUCUUUCCACCCAUCGU	24
#28	AGGGUUGGGAGGGGUCCUUCUUUCGUCUGCGUGGACCGU	25
#16	CAUCCCUAGAGCAGCCAGCCGGAAAGAAGUCACGCCUGCU	26
#17	UAGUGACCGUCAGGUAGGGGGUUAGGCCAUUACGUACGU	27 / 58
#30	GUGCCAACAAUGGAGGUCGGGGUUAGGGUUAAGCCAACGGGU	28

b) IFN-gamma 2'NH₂ Sequences

5'-GGGAGGACGAUGCGG(40N)CAGACGACUCGCCCGA-3'   1

40N

GROUP 1 (25 clones)

		SEQ ID NO.
#7	UAGUAGCGCGAUAUAGCG CUGGUAGGGUUGCCGGGUGAU	29
#B4,B5,B6	UAGUAGCGCGAUAUAGCG CUGGUAGGGUAGCCGGGUG AU	30
#8	UUGUAGCGCGAUAUAGCG CUGGUAGGGUUGCCGGGUGGAU	31

Table 3 (Page 3)

	SEQ ID NO
#B23	UGGUAGCGCGAUAUAGCG CUGGUAGGGUAGCCGGUG AU — 32
#17,24,B3,B10	UGGUAGCGCGAUAUAGCG CUGGUAGGGUUGCCGGUG AU — 33
#33	UUGUAGCGCGAUAUAGCG CUGGUAGGGUUGCCGGUG AU — 34
#31	UGGUAGCGCGAUAUAGCG CUGGUAGGGUUGCCGGUGGGU — 35
#B7	UUGUAGCGCGAUAUAGCG CUGGCAGGGUUGCCGGUGGGU — 36
#11	UGGCAGCGCGAGAUAGCG CUGGUAGGGUUGCCGGUGGAU — 37
#B13	UGGUAGCGCGACAUAGCG CUGGUAGGGUUGCCGGUG AU — 38
#6,14	AAGUGGUGAUCCCAUCUAGGGGUCGGGUUGGGUCGACGGUG — 39
#23	UGUGUGGGGUGCCAUAUAACC CCGGUUGGGUUGACGGUGU — 40
#13,15,18,22,B8	UAGUGCUCACAGAGC GGUUGGGUAGCCGGUGGAUGCGGU — 41
#25	UGUGGGUGCAAUCUAAGCACCGGUUGGGUAGUUCGGUGGCU — 42
#12	AGGCUCAAAAGGC C GGUUGGGUUAGGUAACUGUGGUGCGGU — 43

GROUP 2 (15 clones)

	SEQ ID NO
#16	UAUGGUGGGUUACGCGAGAGUAAGGGUCGCGUGGU — 44
#29	ACGUAUGGUGGGUCGUAGUAUUGGGCUCGUAGCGUGGGU — 45
#30	CAGGUAAUUACAUGAAGGUGGGUUAGGUACUUUCAGGGU — 46
#B9,B22	UAGGUAAUUACAUGAAGGUGGGUUAGGUACUUUCAGGGU — 47
#B12	CAGUAAAUUCGGUAGGGUUAGGUAGGAUCGUGAGGGU — 48
#35	UAUGGUGGGUGCACGUAGGGUGGAAGGGACGUACAUCUGUGCU — 49
#B14	UAUAGGUAACUAUCAGGUGGGAGUCGGUGAAACGGGCUGUUGGU — 50
#32	UACAGGUGGGUCGUGGAUAAUUGGGCACGCUCUAUCUCCU — 51
#B16	CACUAGGUGGGUCGUGGUUGUUGGGGCACGUAACUCGCGU — 52

Table 3 (Page 4)

		SEQ ID NO.
#B24	UACUAGGUGGGUCGUGGUUGUUGGGCACGUAACUUCGCGU	53
#34	ACGUGGCCUUAGAUAGGCAGGUGGGUUAGGCAUAUUCAGU	54
#10	UUCGGCGCCUAAUUAAAGGCAGGAGGGUUAGGCAUUGCU	55
#B2	UGACUACGCCUGUAGUAGGUCGGGUUAGG CAUUGGGCGU	56
#B11	UGCGCCAAUUGCGCCAGGGUCCAGGGUUAGGUAUCUGGGGUAGCU	57

c) IFN-gamma 2'F/NH₂ Sequences

5'-GGGAGGACGAUGCGG(40N)CAGACGACUCGCCCGA-3'   1

40N   60

GROUP 1 (11 clones)

		SEQ ID NO.
#3	UUCAGAGGGUAGGUAAGUGGGAGGAAAAAUGCCGUAUCGCCU	58
#4	AGGUAAGAGAGGAGGGACCUUCCAGUGAAUGUGCGCGUGGU	59
#14	AGGCCUGUGUGAGGAUUGUGGGUGGUGGUGGUGGCCACGCGCGU	60
#32	UCCAAAGAGGGGUGGUGUGGGUGGUGGCACUAAGGUACCGCGU	61
#2	UAUUCGUAAGGCCAGAGCUGCGGGUGGGACCUCCGGCCU	62
#3,A8,13	CCAUAGUGGGUGGGGUUGGGAGUGGAAUAGAGUGCCGAGCGU	63
#15,23,33	UGCACAUGAGGGGUGUGGGAGGAAACGUGACGCGCAUGGU	64
#1	UUCCGUCCGUGGGAUAGAGGUUUGUGGGAUGUACCGGCUGGU	65

61

Table 4

	SEQ ID NO.

Truncated IFN-gamma Ligands

2'F

#1 (Kd=6.8/320 nM full-length; Kd=4.4/716 nM truncate)
5'-gggaggacgaugcggACACCGGUAAUCUGAGGCCCUGCCCUAUUCCUUCACGCGCCUcaga-3'   66

#6 (Kd=3.2/314 nM full-length)
5'-GUUUAAUCUUACUUCCUACUCUUGCUCCACUGGGUcagacgacgacuc-3' (orphan)   67

#16 (Kd=9.3/232 nM full-length)
5'-gggaggacgaugcggCAUCCCUAGAGCAGCCAGCCGGAAAGAAGUCACGCCUGCUca-3' (orphan)   68

#27 (Kd=8.8/384 nM full-length)
5'-gggaggacgaugcggAACACCCCGGUCUGACGCGUUGUUCGAAUUCUCCACCGUUcagacgac-3'   69

#28 (Kd=35 nM full-length; Kd=53 nM truncate)
5'-gggaggacgaugcggAGGGUUGGGGAGGGGUCCUUCUU-3'   (orphan)   70

2'NH₂

#17 (Kd=1.8/750 nM full-length; Kd=12.4 nM truncate)
5'-gggaggacgaugcggUGGUAGCGCGAUAUAGCGCUGGUAGGGUUGCCGGUG-3'   71

#30 (Kd=2.7/103 nM full-length; Kd=11 nM truncate)
5'-gggaggacgaugcggCAGGUAAUUACAUGAUGAAGGUGGGUUAGGUA-3'   72

2'F/NH₂

#3 (Kd=106 nM full-length; Kd=119 nM truncate)
5'-(g)ggacgaugcggUUCAGAGGGUAGGUAAGUGGGGAGGAAAAAAUGCCGUAUCG-3'   73

73

Table 5

	SEQ ID NO.
ON8 TEMPLATES AND PRIMERS	
40N8 ssDNA Template	
5' GGGAGACAAGAATAAACGCTCAA[-40N-]TTCGACAGGAGGCTCACAACAGGC 3'	74
SELEX PCR Primers:	
5P8:	
5' TAATACGACTCACTATAGGGAGACAAGAATAAACGCTCAA 3'	75
3P8:	
5' GCCTGTTGTGAGCCTCCTGTCGAA 3'	76
Cloning PCR Primers:	
5P8H:	
Hind III	
5' CCGAAGCTTTAATACGACTCACTATAGGGAGACAAGAATAAACGCTCAA 3'	77
3P8B:	
Bam HI	
5' GCCGGATCCGCCTGTTGTGTGAGCCTCCTGTCGAA 3'	78
PCR Sequencing Primer:	
pUC19F30:	
5' AGTCACGACGTTGTAAAACGACGGCCAGTG 3'	6

62

Table 6
SELEX STRATEGY

Interleukin-4 (IL-4)

Round	[Protein]	RNA:Protein	RNA Pre-filtration	Stringent Wash	Bio-spin purified RNAs
1	10^{-6}	5			
2	10^{-6}	2.5			
3	10^{-6}	1.5			
4	10^{-6}	1			
5	10^{-6}	1	X		
6	10^{-6}	1			
7	5×10^{-7}	1	X		
8	10^{-7}	1	X	X	
9	10^{-7}	1	X	X	
10	10^{-7}	1	X	X	
11	10^{-7}	1.5	X	X	X
12	10^{-7}	1.5	X	X	X
13	10^{-7}	1.5	X	X	
14	2×10^{-8}	5	X		X
15	10^{-8}	5	X	X	X
16	2×10^{-9}	5			X
17	10^{-9}	5	X		X

64

Table 7

a) IL-4 2'F Sequences

5'-GGGAGACAAGAAUAAACGCUCAA(40N)UUCGACAGGAGGCUCACAACAGGC-3'   74

40N

GROUP 1 (29 clones)

Clone	Sequence	SEQ ID NO.
#2	CUAUGGGGGAGCCACAUU AACGGCAAUAAAUCAUUACGAC	79
#3	CUAUGGGGGAGCCACAUU AACGGCUAUAAAACACAUUACGAC	80
#6	CUCGGGAGCCAGAGUAAC AACGGCAUUAUAUAAUUUACU	81
#7,8,11,16	UCCCACCGGGGGGUGCCACGGUUUA AACGGCUUAAAUAUGAAU	82
#12	GUCUGACUAUUGGGGGCGCCACAAUAUC AACGGCUGUAC	83
#17	UCCCACCGGGGGGUGCCACGGUUUA AACGGCUUAAUAUUUACU	84
#19	GUCUUCCAUGGGGGAGCCACAUU AACGGCGCAAUACUGAAC	85
#22,27,34,40	CUCGGGAGCCAGAGUAAC AACGGCACUAUAUAAUUUACU	86
#26	CUAUGGGGGAGCCACAUU AACGGCAAUAAAUCAUUACGAC	87
#28	AGUGGGGGAGCCACACUAA AACGGCAUAUGACAUCGUCCC	88
#31	UCUCCUCAUGGGCGCCACAUGGUUUAACGGCAUAUCACU	89
#32	CUAUGGGGGAGCCACAUU AACGGCUAUAAAUCAUUACGAC	90
#35	ACUGGGGGAGCCACAGAUU AACGGCGCAUAUGAGUUGAGC	91
#39	CUCUCACUGGGGGAGCCACAGUUUA AACGGCAAGGGAGA	92
#41	CAUCAGAUGGGGGUGCCACAUCAUCA AACGGCUAUAUA	93
#44	ACUGGGGGAGCCACAGAUU AACGGCACAUAUGAUUGAGC	94
#42	AACGGCUGUAACAAACAAGGUGGGGGGCCACCAG AGCGGC	95
#9,15,1,33,46	ACGGCUGUAACAAACAAGGUGGGGGGCCACACAGAGCGGGUUCGAC	96
#25	ACGGCUGUGACAAACAAGGUGGGGGGCCACACAGAGCGGG	97

65

Table 7 (Page 2)

		SEQ ID NO.

ORPHANS (12 clones)

# 4	AUAGCAGAGAGCCCAUGGCGGGAGGAGGAUUGUGGUGGAA	98
#13	CAUCGACGACCAGAGGUAGUGGGGGGGAUGGGAUGCGCCG	99
#14	ACCUAACAUCUUACCAUAUUCAAUUACAUUACACACUAU	100
#18	GCUGCCCAAGGAAUUUAACUGGACCGCGAUCUGGAGUC	101
#21	AGGAGCGCCAUGAAGCAAAGGAGGAUUGUGGUGGAAGGC	102
#23	CCGUAUUAACACUUAUUUUACAAUUUUUCAUA	103
#24	GGUACGACCAAGGAAUGUGGGGUGAAGAGGUGCCGUACC	104
#30	GACGAACGACCACGGAUGGGUGGGCAAAUAGGGAUGCCG	105
#38	GCUAACCCGUACAAAUUUCUUUUUCAUUUUCAUCACUA	106
#43	CUCGGGAGCCAGAGUAACACGGCACUAUAUAAUUUUACC	107
#47	CGACCCGACCAAGGGUAGCCAUGUGGGGGGUGCCGGG	108
#48	UCCGAACAUGGGGUGCCACAAAAACGGCUAUUAUCACUAU	109

b) IL-4 2'NH₂ Sequences

40N

5'-GGGAGACAAGAAUAAACGCUCAA(40N)UUCGACAGGAGGCUCACAACAGGC-3'   74

GROUP 1 (21 clones)

#12	GGACUGG UGAGCCACG	UAUA CGGUCUUAGGGGGCUUGGGGCG	110
#27	CCUGUGG GGAGCCACG	UAUA CGGCCAUAGCAUACCGCAA	111
#29	GAGCUGG UGAGCCACG	UAUA CGGCCCUUAGGGGGCUUGGGGCG	112

Table 7 (Page 3)

			SEQ ID NO.
#B31	GAGCUGG UGAGCCACG	UAUA CGGUCUUAGGGGGCUUGGGGCG	113
#17	GUAUUGG GGAGCCACAU	UACAACGGCACAGGCAACCAGGG	114
#31	GUGCUGG UGAGCCACGC	AUA CGGUCUUAGGGGGCUUGAGCG	115
#B14,B19	UAAAUGG AGAGCCACAC	UA A CGGCGUAUGAAAACACUCA	116
#B16,B17	UCACAAGCACCCUUGG GGAGCCACA	UUAA CGGCCUAGGC	117
#B26	AUGG AGAGCCACA	UUAA CGGCAGCAUAUCACAGUAGGAA	118
#B8	UGUGG GGAGCCACAG	UUAA CGGCUUCAACUGAUUAGAA	119
#B24	AGAUUAAAGUAUAUUGG GGAGCCACA	UCAA CGGCAUGUG	120
#B29	UGACUGAACGAUGGUAUUGG AGAGCCACA	UCAA CGGCAAU	121
#22	CAGAUGGUAUCUAGUGG AGAGCCACA	UCAA CGGCGCAGA	122
#B5	CGAUAGUAUACACAUGAUGAUGG GGAGCCACG	UGUA CGGC	123
#B18,B20	CGAUGG AGCGCCACAUCGCUAUAACGGCUAUAACGGCAUUAACAAAAU		124
#B33,B34	GCGGUCUGAUUGAGCCACCG	UGGA GGGUACGUGGAGGGA	125
#6'ACAAUUUCACACAGAAACAGCUAUGACCAUGAUUACGCCA			126
	AGCUUUGG GGAGCCACA	UAUAACGGGCAUGAUCAAAUAUAG	127

ORPHAN (1 clone)

		SEQ ID NO.
#32	AUACAAUGUGGUUGAAGCUACCUCCCACUCGUAGUGGGCC	128

NITROCELLULOSE FILTER BINDERS (35 clones)

		SEQ ID NO.
#1,B4	CCGUAGCCUCCAGCGGAACGCGGAGGGUACGUGGAGGGG	129
#2,3,24,25,26,36,B9,B15,B22		
	CCGUAGCCUCCAGCGAAUGCGGAGGGCACGUGGAGGGG	130
#5	GAGCCUCCGUGAAUGACGUGGAGGCACGC GGAGGGGAA	131
#8	UCGAUACUACUCCUGGAGAAAGGGAGGACCGU GGAGGA	132
#10	UCGAUACUACUCCUGGAGAAAAGGGAGGAUCGU GGAGGA	133

Table 7 (Page 4)

	Sequence	SEQ ID NO.
#11,B6	GCGGUCUGAUUGAGCCUCCGUGGAGGGUACGUGGAGGGA	134
#18	AGGGUGGAUUGU GGAGGAAUGAGUGUCUAUGGACUCCA	135
#19	UCGAUACUACUCCUGAGAAAAGGGAGGAUCGU GGAGGAA	136
#28	CCGAUACUACUCCUGAGAAAAGGGAGGAUCGU GGAGGAA	137
#30	GGGAGGAUAGU GGAGGAAGAGCCGUGUAAUAAUGUUACGA	138
#34	UCGUAGCCUCCAGCGGGAAUGCGGAGGGCACGUGGAGGGG	139
#35	UCGAUACUACUCCUGAGAAAAGGGAGGAUCGU GGAGGAA	140
#B3	CCGCAGCCUCCAGCAAUGCGGAGGGCACGUGGAGGGG	141
#B7	GAGCCUCCGAGAAUGACGUGGAGGGUACGUGGAGGGGUA	142
#B11	CCGUAGCCUCCAGCGAACGCGGAGGGCACGUGGAGGGG	143
#B12	UGCCGAGAGGAGGGCUGA GGAGGACGCGGCAUUAAGUGA	144
#B13	UCGAUACUACUCCUGAGAAAAGGGAGGAUCGU GGAGGAU	145
#B23	GAGCCUCCGAGAAUGACGUGGAGGGCACGUGGAGGGAA	146
#B25	UGCUGAGAGGAGGGCUGA GGAGGACACGGCAGUAUGAGA	147
#B27	ACGUAGCCUCCAGCGGAAUGCGGAGGGCACGUGGAGGGG	148
#B28	GCGGUCUGAUCGAGCCUCCGUGGAGGGUACGUGGAGGGA	149
#B30	GCGGUCUGAUUGAGCCUCCGUGGAGGGCACGUGGAGGGA	150
#B32	UGCCGAGAGGAGGGCUGA GGAGGACACGGCAGUAUGUAA	151
#B36	CCGUAGCCUCCAGCGGAAUGUGGAGGGCACGUGGAGGGG	152
#9	AAGGUGGGUCGU GGAGGAAUGAGCUCCGUCCCAGCUAA	153

c) IL-4 2'F/NH₂ Sequences

5'-GGGAGACAAGAAUAAACGCUCAA(40N)UUCGACAGGAGGCUCACAACAGGC-3'   74

SEQ ID
NO.

Table 7 (Page 5)

40N

GROUP 1 (7 clones)

		SEQ ID NO.
#9	AGAGUGCAGGUCUGGGGCGCCACA AUUACA ACGG CAAUAA	154
#19	GUCUUCCAUGGGGGAGCCACAUUA ACGGCGCAAUACUGAAC	155
#13	CUCGGGAGCCAG AGUAACAACGGCACUAUAUAAUUUAC	156
#25	AGAGCCGUUUGGGGGACCCAC AGUA ACGGGUUUAUGGUA	157
#8,10	GUCGGAGCGAUGGAGAGCCACG AUAU ACGGUCUGUGCGC	158
#41	AGUAACGUGGGAGCCACACGU AAU ACGGCACUAA	159

GROUP 2 (11 clones)

		SEQ ID NO.
#16	GGUACGA CCAAG GAAUGUGGGUGGAAG AGGGCGCCGUACC	160
#28	GAUCCUGCGACGCCA GGGGUGGAU AGGGGGAAGGGAGCGG	161
#2	GACGAACGA CCAAG GGACGGGUGGGCAAAU AGGGAUGCCG	162
#11,22,29,30,44,45		
#43	GGUACGA CCAAG GAAUGUGGGUGGAAG AGGGUGCCGUACC	163
#14	CAACGCUGA CCA UGGGAGGAAUGUGGGAAGGGGCCCAGCG	164
	CAGCCA AGGGGUGGAUAGGGGGGUAGAGGCCGUAGCAGCG	165

ORPHAN (1 clone)

		SEQ ID NO.
#18	CCGCCUGCGAUAGUUAGACCGUUGAGCUGAGAGCAACACU	166

NITROCELLULOSE FILTER BINDERS (11 clones)

Table 7 (Page 6)

		SEQ ID NO.
#1	AAGGUGGGUUGAGGAGGAAAGUAGCGUGAGUCAGUACCA	167
#4	AGGGAGGAUUGUGUGGAGGAAGGGAAGUGUCCCAGCC	168
#5	GGAUGACCAAGCGUCGAACGAGGAGGAUUGUGGUGGAGG	169
#12	GGGUGGAUUGUGUGGAGGAAGUAGCGCCAGGGUUCCGUAAGCC	170
#21	AGGGAGCGCCAUGAAGCAAAGGAGGAUUGUGGUGGAAGGC	171
#24	ACUGGAGCCAUACAGACGAGAGGAUGGGGUGUGUGGAGGA	172
#31	AGGGAGGAUUGUGUGGAGGAAGGGAGUGGAAGUGUCUCAGCC	173
#32	UCGGGUGAGGACUGGUAGAAAAGGACGGUUGUGUGGAGGAG	174
#34	ACCUGAUAACCGCGGAGGACGAUAGAGGAGGAAGUGCGG	175
#35	AGGCAGCCCCUCGACGAGAAAGGUAGGUAGUGGAGGAAC	176
#42	CUUACGACACCAAAGGGAGGAUUGUGUGGAAUGGGGUCG	177

Table 8

Truncated IL-4 Ligands

2'F

#9 (Kd=14.7 nM full-length; Kd=18 nM truncate)
5'-(ggg)aaACGGCCUGUAACAAACAAGGUGGGGGGCCACACA-3'

SEQ ID NO. 178

#12 (Kd=30 nM full-length)
5'-gggagacaagaauaaacgcucaaGUCUGACUAUUGGGGCGCCACAAUAUCAACGGC-3'

SEQ ID NO. 179

#18 (Kd=43 nM full-length)
5'-aagaauaaacgcucaaGCUGCCCAAGGAAUUUAACUUGGACCGCGAUCU-3' (orphan)

SEQ ID NO. 180

#21 (Kd=11 nM full-length)
5'-AAGCAAAGGGAGGAUUGGGUGGUUGGAAGGCUUC-3' (orphan)

SEQ ID NO. 181

2'NH₂

#29 (Kd=8.3 nM full-length; Kd=10 nM truncate)
5'-(ggg)acgcucaaGAGCUGGUGAGCCACGUAUAUACGGCCUUAGGGGGGCUUGGGGCG-3'

SEQ ID NO. 182

2'F/NH₂

#9 (Kd=3.3 nM full-length)
5'-gggagacaagaauaaacgcucaaAGAGUGCAGGUCUGGGGCGCCACAAUUAGAACGGGCA-3'

SEQ ID NO. 183

#18 (Kd=30 nM full-length)
5'-gcucaaCCGCCUGCGAUAGUUAGACCG-3' (orphan)

SEQ ID NO. 184

#28 (Kd=8.7 nM full-length)
5'-CCUGCGACGCCAGGGGUGGAUAGGGGGGAAGGGGAGCGGuucgacagga-3'

SEQ ID NO. 185

Table 9

	SEQ ID NO.

Initial random sequence RNA pool:

5'-GGGAGACAAGAAUAAACGCUCAA-(N)$_{40}$-UUCGACAGGAGGCUCACAACAGGC-3'   186

5'-Primer:

5'-TAATACGACTCACTATAGGGAGACAAGAATAAACGCTCAA-3'   187

3'-Primer:

5'-GCCTGTTGTGAGCCTCCTGTCGAA-3'   188

72

Table 10 .

43	(10):	ACAUCGUAUAA---CUCUA-AGGGCCUGGAUAUACGAUGAA	189
64	:	ACAUCGUAUAA---CUCUA-AGCGCCUGGAUAUACGAUGAA	190
64a	:	ACAUCGUAUAA---CUCUA-AGAGCCUGGAUAUACGAUGAA	191
64b	:	ACAUCGUAUAA---CUCUA-AGUGCCUGGAUAUACGAUGAA	192
55 5	:	ACAUCGUAUAAU--CUCUA-AGAGCCUGGAUAUACGAUGAA	193
68	:	ACAUCGUAUAAUCUCUCUA-AGAGCCUGGA-AUACGAUGAA	194
6	:	AUCCCA-AU---CUCUA-AGAGCCUGGA-U---AAGAAUGCGCAUUGGGC	195
54	:	AUCCCA-AU---CUCUA-AGAGCCUGGA-U---GACAAU-CGCAUUGGGC	196
57	:	AUCCCA-AU---CUCUA-AGAGCCUGGA-U---GAGAAUGCGCAUUGGGC	197
10	:	CUGAGAU---CUCUA-AGAGCCUGGACU-CAG-CUCCGACUGACC	198
34	:	CUGAGAU---CUCUA-AGAGCCUGGACU-CAG-CUCCGAUUGAUCC	199
41	:	CUGAGAU---CUCUA-AGAGCCUGGACU-CAG-CUCCGAUUGAACC	200
15(2)	:	UCUCUA-UGAGCCUGGA-U-CGACGAACUCUCUACGGGCUGUG	201
56(2)	:	UCUCUA-AGAGCCUGGA-U-GUCGAGGGGCCAUUUCGCACGC	202
2	:	AUCUCUACUGAGCCUGGA-U-UCGCCAGAAGUUUUAUCACAGU	203
59	:	CGUAAAAGUUAUCGAAU--CUCUG-UGAGCCUGGA-U-CGAUUAC	204
3	:	CUGAGAU---CUCUA-AGAGCCUGGACUCAGCUACGAUUGAGCGUUUAUUCUUG	205

73

Table 11

	SEQ ID NO.

STARTING RNA:

5'-GGGAGCUCAGAAUAAACGCUCAA (N$_{30}$) UUCGACAUGAGGCCCGGAUCCGGC   206

PCR PRIMER 1:

   BamH I
5'-GCCGGATCCGGGCCTCATGTCGAA   207

PCR PRIMER 2:

   Hind III
5'-CCGAAGCTTAATACGACTCACTATAGGGAGCTCAGAATAAACGCTCAA   208
        T7 promoter

TABLE 12

Sequences of the hTNFα ligands[a]

Clone	5' constant	random	3' constant	K_D, nM[d]	Class	SEQ ID NO
1A[b] (2)[c]	gggagctcagaataaacgctcaa	ACGGCTGACAACGGCTGGGACTTGCGTATTG	ttcgacatgagggcccggatccggc			209
2A (3	gggagctcagaataaacgctcaa	GACCATTCGTAGGGTCGCCCTTG	ttcgacatgagggcccggatccggc			210
3A (2)	gggagctcagaataaacgctcaa	GACGCATGAGTCGCCTCATCGCTCC	ttcgacatgagggcccggatccggc	135	I	211
4A	gggagctcagaataaacgctcaa	CGCACTCGGACGGAATCTCCGTAGGACACG	ttcgacatgagggcccggatccggc	320	II	212
5A	gggagctcagaataaacgctcaa	TGTCATGCATGTGTCGCCTCATCACGCA	ttcgacatgagggcccggatccggc			213
6A(7)	gggagctcagaataaacgctcaa	CCACTGGCTAGGAACTCGAGTACTGGGTGG	ttcgacatgagggcccggatccggc	120	II	214
7A(2)	gggagctcagaataaacgctcaa	TTCGAAGCCACGTTTCATGTCCGTCGCTGC	ttcgacatgagggcccggatccggc			215
8A	gggagctcagaataaacgctcaa	CAGTGGAGGCTGTCCAAACCACCCACCCC	ttcgacatgagggcccggatccggc	785	I	216
9A(4)	gggagctcagaataaacgctcaa	GTGGAGGGTACGTGGAGGGGAGAGCGATA	ttcgacatgagggcccggatccggc			217
10A	gggagctcagaataaacgctcaa	TCTTCATGCTCGCGTGCGCCTCAACCA	ttcgacatgagggcccggatccggc			218
11A	gggagctcagaataaacgctcaa	TCCCTCCAGTGTCAAGTGCGTCGCCTCAGCA	ttcgacatgagggcccggatccggc			219
12A	gggagctcagaataaacgctcaa	CTTCTTGGCCCCGTCTCAATGTCCGTACTTC	tcttcgacatgagggcccggatccggc			220
13A(2)	gggagctcagaataaacgctcaa	CGTGATTTGGCCACGGGAAAGAGCCATACC	ttcgacatgagggcccggatccggc			221
14A(4	gggagctcagaataaacgctcaa	CGTTGAACGCTTGGTTTCATGTCCCTCGCC	ttcgacatgagggcccggatccggc			222
15A	gggagctcagaataaacgctcaa	CGTCGATCGCGTGCTGTGTAGCCTCAGGCACC	ttcgacatgagggcccggatccggc			223
16A	gggagctcagaataaacgctcaa	GGTGGAAGGCCTTTGAAGCCCGTACATCTCC	tcttcgacatgagggcccggatccggc			224
17A	gggagctcagaataaacgctcaa	GGTCGAACTAGCGCTGGAGCGTGCGTTGGT	ttcgacatgagggcccggatccggc			225
18A(2)	gggagctcagaataaacgctcaa	GTCGCTCGATCGTTTCATGCCCGTCCGACC	ttcgacatgagggcccggatccggc			226
19A	gggagctcagaataaacgctcaa	GTCGATGCGCAGTCCGCCTCAGCTGCACTG	ttcgacatgagggcccggatccggc			227
20A(3)	gggagctcagaataaacgctcaa	GGTGTGCCCAAGGCCCTTGAGAGAGGCGTG	ttcgacatgagggcccggatccggc			228
21A	gggagctcagaataaacgctcaa	GTCTAGGAACTGCGTCGCCTCAACGCGC	ttcgacatgagggcccggatccggc			229
22A	gggagctcagaataaacgctcaa	GTCGGATGGTTTTGCGCGTTTCCCG	ttcgacatgagggcccggatccggc			230
23A	gggagctcagaataaacgctcaa	CCTCATCCTCGCCACCTGCCTGAACCG	ttcgacatgagggcccggatccggc	52	I	231
24A	gggagctcagaataaacgctcaa	GGTGTGCCAAAGGCCCTTGAGAGAGGCGTA	ttcgacatgagggcccggatccggc			232
25A(2)	gggagctcagaataaacgctcaa	GGCCCGCATGCCCCTCCTAACAGCATGCAAC	ttcgacatgagggcccggatccggc	40	I	233
26A	gggagctcagaataaacgctcaa	CCCTCGTGCGCTTGGAGCGGTGGCGCA	ttcgacatgagggcccggatccggc			234
27A	gggagctcagaataaacgctcaa	GTCGCTCGATCGTTTCATGTCCGTTCGACC	ttcgacatgagggcccggatccggc			235
28A	gggagctcagaataaacgctcaa	GTCCCACACTTTGCCGAGCGTCCTAGTG	ttcgacatgagggcccggatccggc			236

TABLE 12 (Page 2)

Sequences of the hTNFα ligands[a]

Clone	5' constant	random	3' constant	Kb,nM[d]	Class	SEQ ID NO
1C	gggagctcagaataaacgctcaa	CGGGTGAATCACGGCTGGTGCGTTGCCCC	ttcgacatgaggcccggatccggc			237
2C(2)	gggagctcagaataaacgctcaa	CGTCGACGCACTGTGCCGCCTCACACACGC	ttcgacatgaggcccggatccggc			238
3C(2)	gggagctcagaataaacgctcaa	GCGAACGTCATGCCCGCCTCATCATGCCACG	ttcgacatgaggcccggatccggc			239
4C	gggagctcagaataaacgctcaa	CTAGGCCCACCGTCCCTTCTAACAACGTC	ttcgacatgaggcccggatccggc	92	I	240
5C	gggagctcagaataaacgctcaa	CAGTCACGAACGTGCGCCGGAAGAACGCTC	ttcgacatgaggcccggatccggc			241
6C	gggagctcagaataaacgctcaa	TGTCGCACGTGTCCCGGCCCGCCCTACCCC	ttcgacatgaggcccggatccggc			242
7C (2)	gggagctcagaataaacgctcaa	CAGGTGGCACCGCCCTTCCAACACGGTGCG	ttcgacatgaggcccggatccggc	297	I	243
8C (2)	gggagctcagaataaacgctcaa	GTCCACACTTTGCCGAGCGTCCTAGTG	ttcgacatgaggcccggatccggc	430	II	244
9C	gggagctcagaataaacgctcaa	ATGGTGGAGGCCATCTCAAACCCACGACAC	ttcgacatgaggcccggatccggc	120	I	245
10C	gggagctcagaataaacgctcaa	CGCCGAGACCCACCTCATAACACCGCTACC	ttcgacatgaggcccggatccggc	500	I	246
11C	gggagctcagaataaacgctcaa	TGAGGCGCGCCACAGGATGCCCTCAACCC	ttcgacatgaggcccggatccggc	140	I	247
12C	gggagctcagaataaacgctcaa	GTCCGCATGATGCTTCGAACAGCATACAAC	ttcgacatgaggcccggatccggc	690	I	248
13C	gggagctcagaataaacgctcaa	GGTGTGCCCTACGTGCGGCCCTTCGTTTA	ttcgacatgaggcccggatccggc			249
14C	gggagctcagaataaacgctcaa	CGGCTTGCAGGTCGCCGAAATGACCGCACA	ttcgacatgaggcccggatccggc	60	II	250
15C	gggagctcagaataaacgctcaa	CTAGTTCAACCGTCCCTTCTAACAACCGTC	ttcgacatgaggcccggatccggc	124	I	251
16C	gggagctcagaataaacgctcaa	CCTGGTGCTGGTCGTGCGGATCGCCTCAAGG	ttcgacatgaggcccggatccggc	200	I	252
17C	gggagctcagaataaacgctcaa	GATCGAAGTTGTCGTCCGCCTCAGCGACTC	ttcgacatgaggcccggatccggc			253
18C	gggagctcagaataaacgctcaa	TGTCGAGTGCGATGGAGGAGTAGGGATGCA	ttcgacatgaggcccggatccggc	.460	O	254
19C	gggagctcagaataaacgctcaa	CCCTCAATGTCGATCGTGTCAAGGTCCGTCCTACTTC	ttcgacatgaggcccggatccggc	83	I	255

[a]Only unique sequences are shown. A unique sequence is defined as one that differs from all others by three or more nucleotides.

[b]Clone numbers followed by "A" were obtained from the round 23A or the round 6C pool. Clone numbers followed by "C" were obtained only from the round 6C pool.

[c]The number in parentheses indicates the occurrence of the clone in the sequenced pool.

[d]No value is shown for ligands that have Kd greater than 1μM.

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TABLE 13

**Binding specificity of the evolved
pool of ligands from round 23A**

Target	KD, nM	Ratio: $K_D^{Target}/K_d^{hTNF\alpha}$
hTNFα	700	1
hTNFß	>1,000,000	>1,400
mTNFα	>1,000,000	>1,400

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TABLE 14

Ki values of hTNFα competitors on the U937 cell competition assay

Competitior	Ki, nM	R*
sTNF-R2	3.3	0.99323
random RNA	>1,000,000	
6A	9,100	0.93776
25A	21	0.98105
4C	1,200	0.93496
14C	930	0.88453
18C	2,500	0.97483

*Fit correlation coefficient

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TABLE 15

Effect of 2'F-pyrimidine modification in the affinities and inhibitory activities of the hTNFα ligands

Clone	2'OH K_D, nM	2'F K_D, nM	2'OH[a] K_i, nM	2'F K_i, nM	Class
3A (2)	135	623			I
4C	92	NB[b]	1,200		I
7C (2)	297	442			I
8A	785	ND[c]			I
9C	120	400			I
10C	500	NB			I
11C	140	NB			I
12C	690	NB			I
15C	124	NB			I
16C	200	123	~313	9,191	I
19C	83	NB			I
23A	52	400	~241	14,671	I
25A (2)	40	445	21		I
4A	320	178			II
6A (7)	120	74	9,100	8,156	II
8C (2)	430	503			II
14C	60	133	930	11,540	II
18C	460	NB	2,500		O

[a]Ki values were obtained based on 5-8 point curves except for 16C and 23A 2'OH ligands where only 3 points were used.
[b]No binding.
[c]Not determined.

Table 16

	SEQ ID NO.

Starting DNA:

40N7:

5'GGGAGGACGATGCGG[-40N-]CAGACGACTCGCCCGA 3'   256

SELEX PCR Primers:

5G7:

5'GGGAGGACGATGCGG 3'   257

3G7:

5'XXXXTCGGGCGAGTCGTCTG 3'   258

X=biotin

TABLE 17

Conditions and progress of the SELEX Process against RANTES

Round	[DNA], M	[RANTES], M	net % bound	Signal/ noise	PF[a]	PS[b]	B-Wash[c] (ml)	U-Wash[d] (ml)	SPKD[e], M KD[f]	nM
150 mM NaCl										
1	3.00E-05	3.0E-06	0.5	35.0	+		25	25	1.24E-03	3000
2	3.30E-06	3.3E-07	0.1	7.8	+		25	25	1.01E-03	
3	3.00E-06	3.0E-07	0.1	1.4	+		25	25	1.85E-03	
4	1.00E-06	1.0E-07	0.2	1.5	+		25	25	2.20E-40	
5	3.00E-07	3.0E-08	0.2	1.5	+		25	50	4.09E-05	
6	1.00E-07	1.0E-08	0.2	1.9	+		50	100	7.89E-06	
7	1.00E-07	1.0E-08	0.4	1.5	+		50	100	1.91E-06	890
8	3.00E-08	3.0E-09	0.3	1.9	+	+	50	100	1.89E-06	
9	3.50E-08	3.0E-09	0.5	1.9	+	+	50	100	9.85E-07	
10	3.00E-08	3.0E-09	0.3	1.4	+	+	50	100	1.90E-07	
11	2.70E-08	3.0E-09	1.4	6.1	+	+	50	100	2.44E-06	
12	1.20E-08	3.0E-09	0.1	1.2	+	+	50	100	1.60E-06	159
13	3.00E-08	1.0E-08	0.6	2.0	+	+	10		4.96E-06	
14	2.50E-08	1.0E-08	0.2	2.0	+	+	5		1.39E-06	
15	2.50E-08	1.0E-08	0.7	3.0	+	+	5		1.96E-06	
16	2.50E-08	1.0E-08	0.5	3.5	+	+	5		1.48E-06	
17	9.00E-09	3.0E-09	0.2	1.5	+	+	5			
18	6.00E-09	3.0E-09	0.2	1.4	+	+	5		1.49E-06	49
19	9.00E-09	3.0E-09	0.2	1.3	+	+	5		1.48E-06	18

[a] Prefiltered DNA through nitrocellulose to counter select for nitocellulose binding molecules

[b] Preadsorption of the DNA under binding conditions

[c] Volume of buffer used to wash the captured complexes

[d] Volume of 0.5M urea wash following the buffer wash

[e] Calculated single point K_D from the binding data at each round

[f] K_D values obtained from binding curves

References

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References

Adams, D. O., and T. A. Hamilton (1984) *Annu Rev. Immunol.* 2:283-318.

Adams, S. M., and R. Blakesley (1991) *Focus* 13 (2):56-58.

Aggarwal, B. B., W. J. Kohr, P. E. Hass, B. Moffat, S. A. Spencer, W. J. Henzel, T. S. Bringman, G. E. Nedwin, D. V. Goeddel, R. N. Harkins (1985) *J. Biol. Chem.* 260:2345-2354.

Alam, R., S. Stafford, P. Forsythe, R. Harrison, D. Faubic, M. A. Lett-Brown, J. A. Grant (1993) *J. Immunol.* 150:3442-3447.

Allen, P. M., and E. R. Unanue (1987) *Adv. Exp. Med. Biol.* 225:147-154.

Anderson, P., Y. K. Yip, J. Vilcek (1982) *J. Biol. Chem.* 257:11301-11304.

Bancroft, G. J., R. D. Schreiber, G. C. Bosma, M. J. Bosma, E. R. Unanue (1987) *J. Immunol.* 139:1104-1107.

Bancroft, G. J., K. C. F. Sheehan, R. D. Schreiber, E. R. Unanue (1989) *J. Immunol.* 143:127-130.

Bazan, J. F. (1990) *Immunol. Today* 11:350-354.

Belosevic, M., D. S. Finbloom, P. H. VanderMeide, M. V. Slayter, C. A. Nacy (1989) *J. Immunol.* 143:266-274.

Beutler, B., and A. Cerami (1989) *Ann. Rev. Immunol.* 7:625-655.

Beutler, B., I. W. Milsark, A. C. Cerami (1985) *Science* 229:869-871.

Bischoff, S. C., M. Krieger, T. Brunner, A. Rot, V. V. Tscharner, M. Baggiolini, C. A. Dahinden (1993) *Eur. J. Immunol.* 23:761-767.

Bowen, B., J. Steinberg, U. K. Laemmli, H. Weintraub (1980) *Nucl. Acids Res.* 8:1-20.

Brennan, F. M., D. Chantry, A. Jackson, R. Maini, M. Feldmann (1989) *Lancet* 2:244-247.

Briscoe, D. M., R. S. Cotran, J. S. Pober (1992) *J. Immunol.* 147:2954-2960.

Brockhaus, M., H. J. Schoenfeld, E. J. Schlaege, W. Hunziker, W. Lesslauer (1990) *Proc. Natl. Acad. Sci. USA* **87**:3127-3131.

Brown, M. A., J. H. Pierce, C. J. Watson, J. Falco, J. N. Ihle, W. E. Paul (1987) *Cell* **50**:809-818.

Buchmeier, N. A., and R. D. Schreiber (1985) *Proc. Natl. Acad. Sci. USA* **82**:7404-7408.

Casadaban, M., and S. Cohen (1980) *J. Mol. Biol.* **138**:179-207.

Casey, L. C., R. A. Balk, R. C. Bone (1993) *Ann. Intern. Med.* **119**:771-777.

Clerici, M., and G. M. Shearer (1993) *Immunol. Today* **14**:107-111.

Coffman, R. L., J. O'Hara, M. W. Bond, J. Carty, A. Zlotnik, W. E. Paul (1986) *J. Immunol.* **136**:4538-4541.

Crawford, R. M., D. S. Finbloom, J. O'Hara, W. E. Paul, M. S. Meltzer (1987) *J. Immunol.* **139**:135-141.

Davanloo, P., A. H. Rosenberg, J. J. Dunn, F. W. Studier (1984) *Proc. Natl. Acad. Sci. USA* **81**:2035-2039.

Del Prete, G., E. Maggi, P. Parronchi, I. Chraetien, A. Tiri, D. Macchia, M. Ricci, J. Banchereau, J. DeVries, S. Romagnani (1988) *J. Immunol.* **140**:4193-4198.

Derynck, R., D. W. Leung, P. W. Gray, D. V. Goedell (1982) *Nucl. Acids Res.* **10**:3605-3615.

Dinarello, C. A., and J. G. Cannon (1993) *Ann. Intern. Med.* **119**:853-854.

Ding, A. H., C. F. Nathan, D. J. Stuehr (1988) *J. Immunol.* **141**:2407-2412.

Duh, E. J., W. J. Maury, T. M. Folks, A. S. Fauci, A. B. Rabson (1989) *Proc. Natl. Acad. Sci. USA* **86**:5974-5978.

Eck, M. J., B. Beutler, G. Kuo, J. P. Merryweather, S. R. Sprang (1988) *J. Biol. Chem.* **263**:12816-12819.

Erbe, J. E., Collins, L. Shen, R. F. Graziano, M. W. Fanger (1990) *Mol. Immunol.* **27**:57-67.

Feldmann, M. (1989) *Immunology* Supplement **2**:66-71.

Ferrara, J. L. M., and H. J. Deeg (1991) *N. Engl. J. Med.* **324**:667-674.

Fiedler, V. B., I. Loof, E. Sander, V. Voehringer, C. Galanos, M. A. Fournel (1992) *J. Lab. Clin. Med.* **120**:574-588.

Finkelman, F. D., I. M. Katona, J. F. Urbon, Jr., C. M. Snapper, J. Ottara, W. E. Paul (1986) *Proc. Natl. Acad. Sci. USA* **83**:9765-9778.

Finkelman, F. D., J. Holmes, I. M. Katona, J. F. Urban, Jr., M. P. Beckman, L. S. Park, K. Schooley, R. L. Coffman, T. R. Mosmann, W. E. Paul (1990) *Annu Rev. Immunol.* **8**:303-333.

Finkelman, F. D., I. M. Katona, J. F. Urban, Jr., W. E. Paul (1989) In Ciba Foundation Symposium. IgE, Mast Cells and the Allergic Response. Wiley. Chichester, pp.3-22.

Folks, T. M., K. A. Clouse, J. Justment, A. Rabson, E. Duh, J. H. Kehrl, A. S. Fauci (1989) *Proc. Natl. Acad. Sci. USA* **86**: 2365-2368.

Galizzi, J. P., C. E. Zuber, N. Harada, D. M. Gorman, O. Djossou, R. Kastelein, J. Banchereau, M. Howard, A. Miyajima (1990) *Int. Immunol.* **2**:669-675.

Gao, J. L., D. B. Kuhns, H. L. Tiffany, D. McDermott, X. Li, U. Francke (1993) *J. Exp. Med.* **177**:1421-1427.

Gazzinelli, R. T., I. P. Oswald, S. L. James, A. Sher (1992) *J. Immunol.* **148**:1792-1796.

Gleichmann, E., E. H. VanElven, J. P. W. VanderVeen (1982) *Eur. J. Immunol.* **12**:152-159.

Gold, L., C. Tuerk, P. Allen, J. Binkley, D. Brown, L. Green, S. MacDougal, D. Schneider, D. Tasset, S. Eddy (1993) In the RNA World. Gesteland, R. F., and J. F. Atkins (eds.). Cold Spring Harbor Laboratory Press.

Grau, G. E., L. F. Fajardo, P. F. Piguet, B. Allet, P. H. Lambert, P. Vassalli (1987) *Science* **237**:1210-1212.

Green, S. J., R. M. Crawford, J. T. Hockmeyer, M. S. Meltzer, C. A. Nacy (1990) *J. Immunol.* **145**:4290-4297.

Greenlund, A. C. (1992) *J. Interferon Res. (Abstr.)* **12**:S103.

Gu, D., L. Wogensen, N. A. Calcutt, C. Xia, S. Zhu, J. P. Merlie, H. S. Fox (1995) *J. Exp. Med.* **181**:547-557.

84

Haak-Frendscho, M., S. A. Marsters, J. Mordenti, S. Brady, N. A. Gillett, S. A. Chen, A. Ashkenazi (1994) *J. Imunol.* **152**:1347-1353.

Harada, N., B. E. Castle, D. M. Gorman, N. Itoh, J. Schreurs, R. L. Barrett (1990) *Proc. Natl. Acad. Sci. USA* **87**:857-861.

Heinzel, F. P. M. D. Sadick, S. S. Mutha, R. M. Locksley (1991) *Proc. Natl. Acad. Sci. USA* **88** 7011-7015.

Heinzel, F. P., M. D. Sadick, B. J. Holaday, R. L. Coffman, R. M. Locksley (1989) *J. Exp. Med.* **169**:59-72.

Hershey, G. K. K., D. W. McCourt, R. D. Schreiber (1990) *J. Biol. Chem.* **265**:17868-17875.

Higuchi, C. M., J. A. Thompson, C. G. Lindgren, S. Gillis, M. B. Widmer, D. E. Kern, A. Fefer (1989) *Cancer Research* **49**:6487-6492.

Hinshaw, L. B., T. E. Emerson, Jr., F. B. Taylor, Jr., A. C. Chang, M. Duerr, G. T. Peer, D. J. Flournoy, G. L. White, S. D. Kosanke, C. K. Murray (1992) *J. Trauma* **33**:568-573.

Hohmann, H. P., R. Remy, M. Brockhaus, A. P. G. M. Van-Loon (1989) *J. Biol. Chem.* **264**:14927-14934.

Hoon, D. S. B., E. Okunn, M. Banez, R. F. Irie, D. L. Morton (1991) *Cancer Research* **51**:5687-5693.

Horuk, R., C. E. Chitnis, W. C. Darbonne, T. J. Colby, A. Rybicki, T. J. Hadley, L. H. Miller (1993) *Science* **261**:1182-1184.

Howard, J. G., C. Hale, F. Y. Liew (1980) *Nature* **288**:161-162.

Howard, M., J. Farrar, M. Hilfiker, B. Johnson, K. Takatsu, T. Hamaoka, W. E. Paul (1982) *J. Exp. Med.* **155**:914-923.

Hsieh, C. -S., S. E. Macatonia, C. S. Tripp, S. F. Wolf, A. O'Garra, K. M. Murphy (1993) *Science* **260**:547-549.

Hu-Li, J., E. M. Shevach, J. Mizuguchi, J. O'Hara, T. Mosmann, W. E. Paul (1987) *J. Exp. Med.* **165**:157-172.

Idzerda, R. L., C. J. March, B. Mosley, S. D. Lyman, T. V. Bos, S. D. Gimpel, W. S. Din, K. H. Grabstein, M. B. Widmer, L. S. Park, D. Cosman, M. P. Beckman (1990) *J. Exp. Med.* **171**:861-73.

85

Isakson, P. C., E. Pure, E. S. Vitetta, P. H. Krammer (1982) *J. Exp. Med.* **155**:734-748.

Jansen, J. H., G.-J. H. M. Wientjens, W. E. Fibbe, R. Willemze, H. C. Kluin-Nelemans (1989) *J. Exp. Med.* **170**:577-582.

Jones, E. Y., D. I. Stuart, N. P. C. Walker (1989) *Nature* **338**:225-228.

Jung, V., A .Rashidbaigi, C. Jones, J. Tischfield, T. B. Shows (1987) *Proc. Natl. Acad. Sci.* USA **84**:4151-4155.

Katona, I. M., J. F. Urban, Jr., S. S. Kang, W. E. Paul, F. Finkelman (1991) *J. Immunol.* **146**:4215-4221.

Keffer, J., L. Probert, H. Cazlaris, S. Georgopoulos, E. Kaslaris, D. Kioussis, G. Kollias (1991) *EMBO J.* **10**:4025-4031.

Khorram, O., R. N. Taylor, I. P. Ryan, T. J. Schall, D. V. Landers (1993) *Am. J. Obstet. Gynecol.* **169**:1545-1549.

Kishimoto, T., T. Taga, S. Akira (1994) *Cell* **76**:253-262.

Kühn, R., J. Löhler, D. Rennick, K. Rajewsky, W. Müller (1993) *Cell* **75**:263-274.

Kühn, R., R. Rajewsky, W. Müller (1991) *Science* **254**:707-710.

Kuna, P., S. R. Reddigari, T. J. Schall, D. Rucinski, M. Sadick, A. P. Kaplan (1993) *J. Immunol.* **150**:1932-1943.

Kuna, P., S. R. Reddigari, T. J. Schall, D. Rucinski, M. Y. Viksman, A. P. Kaplan (1992) *J. Immunol.* **149**:636-642.

Landolfo, S., F. Cofano, M. Giovarelli, Maria Pratt, G. Cavallo, G. Forni (1985) *Science* **229**:176-179.

Le Beau, M. M., R. S. Lemons, R. Espinosa III, R. A. Larson, N. Arai, J. D. Rowley (1989) *Blood* **73**:647-50.

Leal, L. M. C. C., D. W. Moss, R. Kühn, W. Miller, F. Y. Liew (1993) *Eur. J. Immunol.* **23**:566-569.

Lebman, D. A., Coffman, R. L. (1988) *J. Exp. Med.* **168**:853-862.

Lee, F., T. Yokota, T. Otsuka, P. Meyerson, D. Villaret, R. Coffman, T. Mossman, D. Rennick, N. Roehm, C. Smith, A. Zlotnik, K-I. Arai (1986) *Proc. Natl. Acad. Sci. USA* **83**:2061-2065.

Lenardo, M. J., and D. Baltimore (1989) *Cell* **58**:227-229.

Lewis, D. B., H. D. Liggitt, E. L. Effman, S. T. Motley, S. L. Teitelbaum, K. J. Jepsen (1993) *Proc. Natl. Acad. Sci. USA* **90**:11618-11622.

Liew, F. Y., S. Millott, J. Li, R. Lelchuk, Y. L. Chan, H. Ziltener (1989) *Eur. J. Immunol.* **19**:1227-1232.

Loetscher, H., M. Steinmetz, W. Lesslauer (1991) *Cancer Cells* **3**:221-226.

Loetscher, H., Y.-C. E. Pan, H.-W. Lahm, R. Gentz, M. Brockhaus, H. Tabuchi, W. Lesslauer (1990) *Cell* **61**:351-359.

Lowenthal, J. W., D. W. Ballard, E. Boehnlein, W. C. Green (1989) *Proc. Natl. Acad. Sci. USA* **86**:2331-2335.

Lowenthal, J. W., B. E. Castle, J. Christiansen, J. Schreuers, D. Rennick, N. Arai, P. Hoy, Y. Takebe, M. Howard (1988) *J. Immunol.* **140**:456-464.

Mantovani, A., and E. Dejana (1989) *Immunol. Today* **10**:370-375.

McGee, D. P. C., C. Vargeese, Y. Zhai, G. P. Kirschenheuter, A. Settle, C. R. Siedem, W. A. Pieken (1995) *Nucleosides & Nucleotides* **14**:1329-1339.

McInnes, A., and D. M. Rennick (1988) *J. Exp. Med.* **167**:598-611.

Mogi, M., M. Harada, P. Riederer, H. Narabayashi, K. Fujita, T. Nagatsu (1994) *Neurosc. Lett.* **165**:208-210.

Mohler, K. M., D. S. Torrance, C. A. Smith, R. G. Goodwin, K. E. Stremler, V. P. Fung, H. Madani, M. B. Widmer (1993) *J. Immunol.* **151**:1548-1561.

Moore, K. W., P. Vieira, D. F. Fiorentino, M. L. Trounstine, T. A. Kahn, T. R. Mosmann (1990) *Science* **248**:1230-1234.

Moore, K. W., A. O'Garra, R. deWaal Malefyt, P. Vieira, T. R. Mossman (1993) *Ann. Rew. Immunol.* **11**:165-190.

Mosely, B., M. P. Beckman, C. J. March, R. L. Idzerda, S. D. Gimpel, T. VandenBos, D. Friend, A. Alpert, D. Anderson, J. Jackson, J. M. Wignall, C. Smith, B. Gallis, J. E. Sims, D. Urdal, M. B. Widmer, D. Cosman, L. S. Park (1989) *Cell* **59**:335-348.

Mosmann, T. R., M. W. Bond, R. L. Coffman, J. O'Hara, W. E. Paul (1986) *Proc. Natl. Acad. Sci. USA* **83**:5654-5658.

Mosmann, T. R., and R. L. Coffman (1989) *Annu. Rev. Immunol.* 7:145-173.

Mulkerrin, M. G., and R. Wetzel (1989) *Biochemistry* 28:6556-6561.

Munro, J. M., J. S. Pober, R. S. Cotran (1989) *Am. J. Path.* 135:121-131.

Nelson, P. J., H. T. Kim, W. C. Manning, T. J. Goralski, A. M. Krensky (1993) *J. Immunol.* 151:2601-2612.

Neote, K., W. Darbonne, J. Ogez, R. Horuk, T. J. Schall (1993) *J. Biol. Chem.* 268:12247-12249.

Noma, Y., P. Sideras, T. Naito, S. Bergstedt-Lindquist, C. Azuma, E. Severinson, T. Tanabe, T. Kinashi, F. Matsuda, Y. Yaoita, T. Honjo (1986) *Nature* 319:640-46.

Oliff, A., D. Defeo-Jones, M. Boyer, D. Martinez, D. Kiefer, G.Vuocolo, A. Wolfe, S. H. Socher (1987) *Cell* 50:555-563.

Oliver, K., R. J. Noelle, J. W. Uhr, P. H. Krammer, E. S. Vitetta (1985) *Proc. Natl. Acad. Aci. USA* 82:2465-2467.

Osborn, L., S. Kunkel, G. J. Nabel (1989) *Proc. Natl. Acad Sci. USA* 86:2336-2340.

Park, L. S., D. Friend, K. Grabstein, D. L. Urdal (1987) *Proc. Natl. Acad. Sci. USA* 84:1669-1673.

Parrillo, J. E. (1991) *Annals Int. Med.* 115:491-492.

Paul, W. E. (1991) *Blood* 77:1859-870.

Paul, W. E., and R. A. Seder (1994) *Cell* 76:241-251.

Pennica, D., V. T. Lam, N. K. Mize, R. F. Weber, M. Lewis, B. M. Fendley, M. T. Lipari, D. V. Goeddel (1992) *J. Biol. Chem.* 267:21172-21178.

Pieken, W., D. B. Olsen, F. Benseler, H. Aurup, F. Eckstein (1991) *Science* 253:314-317.

Piguet, P. F. (1992) TNF and Alloreactions. Involvement of TNF in the Effector Phase of Graft-Versus-Host and host-Versus-Graft Reactions. TUMOR NECROSIS FACTORS: The Molecules and Their Emerging Role in Medicine. New York, Raven Press, Ltd.

Plaut, M., J. H. Pierce, C. J. Watson, J. Hanley-Hyde, R. P. Nordan, W. E. Paul (1989) *Nature* 339:64-67.

Pober, J. S., M. A. Gimbrone, Jr., L. A. Lapierre, D. L. Mendrick, W. Fiers, R. Rothlein, T. A. Springer (1986) *J. Immunol.* **137**:1893-1896.

Rabin, E., J. O'Hara, W. E. Paul (1985) *Proc. Natl. Acad. Sci. USA* **82**:2935-2939.

Rapoport, M. J., A. Jaramillo, D. Zipris, A. H. Lazarus, D. V. Serreze, E. H. Leiter, P. Cyopick, J. S. Danska, T. L. Delovitch (1993) *J. Exp. Med.* **178**:87-99.

Rathanaswami, P., M. Hachicha, M. Sadick, T. J. Schall, S. R. McColl (1993) *J. Biol Chem.* **268**:5834-5839.

Ravetch, J. V. (1994) *Cell* **78**:553-560.

Rinderknecht, E., B. H. O'Connor, H. Rodriguez (1984) *J. Biol. Chem.* **259**:6790-6797.

Rot, A., M. Krieger, T. Brunner, S. C. Bischoff, T. J. Schall, C. A. Dahinden (1992) *J. Exp. Med.* **176**:1489-1495.

Salgame, P., J. S. Abrams, C. Clayberger, H. Goldstein, J. Convit, R. L. Modlin, B. R. Bloom (1991) *Science* **254**:279-282.

Sato, T. A., M. B. Widmer, F. D. Finkelman, H. Madani, C. A. Jacobs, K. H. Grabstein, C. R. Maliszewski (1993) *J. Immunol.* **150**:2717-2723.

Scahill, S. J., R. Devos, J. VanDerHeyden, W. Fiers (1983) *Proc. Natl. Acad. Sci. USA* **80**:4654-4658.

Schall, T. J. (1991) *CYTOKINE* **3**:165-183.

Schall, T. J., K. Bacon, K. J. Toy, D. V. Goeddel (1990) *Nature* **347**:669-671.

Schall, T. J., M. Lewis, J. Koller, A. Lee, G. C. Rice, G. H. Wong, T. Granger, G. A. Granger, R. Lentz, H. Raab (1990) *Cell* **52**:415-423.

Schall, T. J., N. J. Simpson, J. Y. Mak (1992) *Eur. J. Immunol.* **22**:1477-1481.

Schreiber, R. D., and A. Celada (1985) *Lymphokines.* **11**:87-118.

Schreiber, R. D., M. A. Farrar, G. K. Hershey, J. Fernandez-Luna (1992) *Int. J. Immunopharmac.* **14**:413-419.

Shanafelt, A. B., A. Miyajima, T. Kitamura, R. A. Kastelein (1991) *EMBO J.* **10**:4105-4112.

Sher, A, and R. L. Coffman (1992) *Ann. Rev. Immunol.* **10**:385-409.

Sher, A., R. T. Gazzinelli, I. P. Oswald, M. Clerici, M. Kullberg, E. J. Pearce, J. A. Berzofsky, T. R. Mosmann, S. L. James, H. L. Morse (1992) *Immunol. Rev.* **127**:183-204.

Singh, H., J. H. LeBowitz, A. S. J. Baldwin, P. A. Sharp (1988) *J. Biol. Chem.* **262**:6951-6954.

Snapper, C. M., and W. E. Paul (1987) *Science* **236**:944-947.

Smith, R. A., and C. Baglioni (1987) *J. Biol. Chem.* **262**:6951-6954.

Spits, H., H. Yssel, Y. Takebe, N. Arai, T. Yakota, F. Lee, K.-I. Arai, J. Banchereau, J. E. DeVries (1987) *J. Immunol.* **139**:1142-1147.

Steinman, L. (1993) *Scientific American* **269** (3):107-114.

Strunk, R. C., F. Sessions Cole, D. H. Perlmutter, H. R. Colten (1985) *J. Biol. Chem.* **260**:15280-15285.

Suzuki, Y., M. A. Orellana, R. D. Schreiber, J. S. Remington (1988) *Science* **240**:516-518.

Sylvestre, D. L., Ravetch, J. V. (1994) *Science* **265**:1095-1098.

Te Velde, A. A., J. P. G. Klomp, B. A. Yard, J. E. DeVries, C. G. Figdor (1988) *J. Immunol.* **140**:1548-1554.

Tepper, R. I., P. K. Pattengale, P. Leder (1989) *Cell* **57**:503-512.

Tepper, R. I., D. A. Levinson, B. Z. Stanger, J. Campos-Torres, A. K. Abbas, P. Leder (1990) *Cell* **62**:457-467.

Thornhill, M. H., S. M. Wellicome, D. L. Mehiouz, J. S. S. Lanchbury, U. Kyan-Aung, D. O. Haskard (1991) *J. Immunol.* **146**:592-598.

Traugott, U., and P. Lebon (1988) *J. Neurol. Sci.* **84**:257-264.

Trenn, G., H. Takayama, J. Hu-Li, W. E. Paul, M. V. Sitkovsky (1988) *J. Immunol.* **140**:1101-1106.

Trinchieri, G., and B. Perussia (1985) *Immunol. Today* **6**:131-135.

Tuerk, C., and L. Gold (1990) *Science* **249**:505-510.

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Umland, S. P., S. Razac, D. K. Nahrebne, B. W. Seymour (1992) *Clin. Immunol. Immunophathol.* **63**:66-73.

Ushiyama, C., T. Hirano, H. Miyajima, K. Okumura, Z. Ovary, H. Hashimoto (1995) *J. Immunol.* **154**:2687-2696.

van Leeuwen, B. H., M. E. Martinson, G. C. Webb, I. G. Young (1989) *Blood* **73**:1142-1148.

van Rappard-van Der Veen, F. M., A. G. Rolink, E. Gleichmann (1982) *J. Exp. Med.* **155**:1555-1560.

Van-Riper, G., S. Sicilianl, P. A. Fischer, R. Meurer, M. S. Springer, H.Rosen (1993) *J. Exp. Med.* **177**:851-856.

Vassalli, P. (1992) *Annu. Rev. Immunol.* **10**:411-452.

Via, C. S., and G. M. Shearer (1988) *Immunol. Today* **9**:207-212.

Vieira, J., and J. Messing (1982) *Gene* **19**:259-268.

Vieira, P., R.deWaal-Malefyt, M. N. Dang, K. E. Johnson, R. Kastelein, D. F. Fiorentino, J. E. DeVries, M. G. Roncarlo, T. R. Mosmann, K. W. Moore (1991) *Proc. Natl. Acad. Sci. USA* **88**:1172-1176.

Visvanathan, K. V., and S. Goodbourn (1989) *EMBO J.* **8**:1129-1138.

Vitetta, E. S., J. O'Hara, C. D. Myers, J. E. Layton, P. H. Krammer, W. E. Paul (1985) *J. Exp. Med.* **162**:1726-1731.

Walter, M. R., W. J. Cook, B. G. Zhao, R. P. Cameron, Jr., S. E. Ealick, R. L. Walter, Jr., P. Reichert, T. L. Naqab-hushan, P. P. Trotta, C. E. Bugg (1992) *J. Biol. Chem.* **267**:20371-20376.

Wang, J. M., D. W. McVicar, J. J. Oppenheim, D. J. Kelvin (1993) *J. Exp. Med.* **177**:699-705.

Wheelock, E. F. (1965) *Science* **149**:310-311.

Widmer, M. B., and K. H. Grabstein (1987) *Nature* **326**:795-798.

Wiedermann, C. J., E. Kowald, N. Reinisch, C. M. Kaehler, I. von-Luettichau, J. J. Pattison, P. Huie, R. K. Sibley, P. J. Nelson, A. M. Krensky (1993) *Current Biology* **3**:735-739.

Williams, R. O., M. Feldmann, R. N. Maini (1992) *Proc. Natl. Acad. Sci. USA*
89:9784-9788.

Yokota, T., T. Otsuka, T. Mossman, J. Banchereau, T. DeFrance, D. Blanchard, J. E.
DeVries, F. Lee, K.-I. Arai (1986) *Proc. Natl. Acad. Sci. USA* 83:5894-5898.

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SEQUENCE LISTING

(1) GENERAL INFORMATION:
  (i) APPLICANT: NEXSTAR PHARMACEUTICALS, INC.
                DIANE TASSET
                NIKOS PAGRATIS
                SUMEDHA JAYASENA
                LARRY GOLD
  (ii)   TITLE: HIGH AFFINITY NUCLEIC ACID LIGANDS OF CYTOKINES
  (iii) NUMBER OF SEQUENCES: 258
  (iv) CORRESPONDENCE ADDRESS:
    (A) ADDRESSEE: Swanson and Bratschun, L.L.C.
    (B) STREET: 8400 East Prentice Avenue, Suite #200
    (C) CITY: Denver
    (D) STATE: Colorado
    (E) COUNTRY: USA
    (F) ZIP: 80111

  (v) COMPUTER READABLE FORM:
    (A) MEDIUM TYPE: Diskette, 3.50 inch, 1.44 Mb storage
    (B) COMPUTER: IBM compatible
    (C) OPERATING SYSTEM: MS-DOS
    (D) SOFTWARE: WordPerfect 6.0

  (vi) CURRENT APPLICATION DATA:
    (A) APPLICATION NUMBER: Unassigned
    (B) FILING DATE:
    (C) CLASSIFICATION:

  (vii) PRIOR APPLICATION DATA:
    (A) APPLICATION NUMBER: 08/477,829
    (B) FILING DATE: 07-JUNE-1995

  (vii) PRIOR APPLICATION DATA:
    (A) APPLICATION NUMBER: 08/481,710
    (B) FILING DATE: 07-JUNE-1995

  (viii) ATTORNEY/AGENT INFORMATION:
    (A) NAME: Barry J. Swanson
    (B) REGISTRATION NUMBER: 33,215
    (C) REFERENCE/DOCKET NUMBER: NEX41/PCT

  (ix) TELECOMMUNICATION INFORMATION:
    (A) TELEPHONE: (303) 793-3333
    (B) TELEFAX: (303) 793-3433

(2) INFORMATION FOR SEQ ID NO: 1:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 71 base pairs
    (B) TYPE: nucleic acid

```
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE: RNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 1:
GGGAGGACGA UGCGGNNNNN NNNNNNNNNN NNNNNNNNNN NNNNNNNNNN        50
NNNNNCAGAC GACUCGCCCG A                                      71


(2)  INFORMATION FOR SEQ ID NO: 2:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  32 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE: DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 2:
TAATACGACT CACTATAGGG AGGACGATGC GG                          32


(2)  INFORMATION FOR SEQ ID NO: 3:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  16 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 3:
TCGGGCGAGT CGTCTG                                            16


(2)  INFORMATION FOR SEQ ID NO: 4:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  40 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 4:
CCGAAGCTTA ATACGACTCA CTATAGGGAG GACGATGCGG                  40


(2)  INFORMATION FOR SEQ ID NO: 5:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  25 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE: DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 5:
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GCCGGATCCT CGGGCGAGTC GTCTG   25

(2)   INFORMATION FOR SEQ ID NO: 6:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 30 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 6:
AGTCACGACG TTGTAAAACG ACGGCCAGTG   30

(2)   INFORMATION FOR SEQ ID NO: 7:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 7:
GGGAGGACGA UGCGGACACC GUUAAUCUGA GGCCCUGUCC UAUUCCUUCA   50
CGCCUCAGAC GACUCGCCCG A   71

(2)   INFORMATION FOR SEQ ID NO: 8:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 8:
GGGAGGACGA UGCGGACACC GUUAGUCUGA GGCCUUGUCC UAUUCCUUCA   50
CGCCUCAGAC GACUCGCCCG A   71

(2)   INFORMATION FOR SEQ ID NO: 9:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA

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    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 9:
GGGAGGACGA UGCGGACACC UUUAAUCUGA GGCCCUGUCC UAUUCCUUCA        50
CGCCUCAGAC GACUCGCCCG A                                       71


  (2)  INFORMATION FOR SEQ ID NO: 10:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  71 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 10:
GGGAGGACGA UGCGGACACC UUGAAUCUGA GGCCCUGUCC UAUUCCUUCA        50
CGCCUCAGAC GACUCGCCCG A                                       71


  (2)  INFORMATION FOR SEQ ID NO: 11:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH: 71 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 11:
GGGAGGACGA UGCGGACACC GUUAAUCUGA GGCCCUGUCC UAUUCCUCCA        50
CGCCUCAGAC GACUCGCCCG A                                       71


  (2)  INFORMATION FOR SEQ ID NO: 12:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  71 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 12:
```

GGGAGGACGA UGCGGACACC GUAGAUCUGA GGCCCUGUCC UAUUCCUCCA   50
CGCCUCAGAC GACUCGCCCG A   71

(2)   INFORMATION FOR SEQ ID NO: 13:
   (i)   SEQUENCE CHARACTERIZATION:
     (A)   LENGTH: 70 base pairs
     (B)   TYPE: nucleic acid
     (C)   STRANDEDNESS: single
     (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: RNA
   (ix)   FEATURE:
     (D)   OTHER INFORMATION: All pyrimidines are 2'-F
           modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 13:
GGGAGGACGA UGCGGACACC GUUAAUCUGA GGCCCUGUCC AUUCCUUCAC   50
GCCUCAGACG ACUCGCCCGA   70

(2)   INFORMATION FOR SEQ ID NO: 14:
   (i)   SEQUENCE CHARACTERIZATION:
     (A)   LENGTH: 71 base pairs
     (B)   TYPE: nucleic acid
     (C)   STRANDEDNESS: single
     (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: RNA
   (ix)   FEATURE:
     (D)   OTHER INFORMATION: All pyrimidines are 2'-F
           modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 14:
GGGAGGACGA UGCGGACACC GUUAAACUGA GGCCCUGUCC UAUUCCUUCA   50
CGCCUCAGAC GACUCGCCCG A   71

(2)   INFORMATION FOR SEQ ID NO: 15:
   (i)   SEQUENCE CHARACTERIZATION:
     (A)   LENGTH: 72 base pairs
     (B)   TYPE: nucleic acid
     (C)   STRANDEDNESS: single
     (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: RNA
   (ix)   FEATURE:
     (D)   OTHER INFORMATION: All pyrimidines are 2'-F
           modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 15:
GGGAGGACGA UGCGGAACAC CCCCGGUCUG ACGCUUGUUC CGAAUUCCUC   50
CACCGUCAGA CGACUCGCCC GA   72

(2)   INFORMATION FOR SEQ ID NO: 16:
   (i)   SEQUENCE CHARACTERIZATION:

```
      (A)   LENGTH:   73 base pairs
      (B)   TYPE:   nucleic acid
      (C)   STRANDEDNESS:   single
      (D)   TOPOLOGY:   linear
   (ii)  MOLECULAR TYPE:   RNA
   (ix)  FEATURE:
      (D)   OTHER INFORMATION:   All pyrimidines are 2'-F
            modified
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   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 16:
GGGAGGACGA UGCGGGAACA CCCCCGGUCU GACGCUUGUU CCGAAUUCCU      50
CCACCGUCAG ACGACUCGCC CGA                                   73
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```
(2)   INFORMATION FOR SEQ ID NO: 17:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:   71 base pairs
      (B)   TYPE:   nucleic acid
      (C)   STRANDEDNESS:   single
      (D)   TOPOLOGY:   linear
   (ii)  MOLECULAR TYPE: RNA
   (ix)  FEATURE:
      (D)   OTHER INFORMATION:   All pyrimidines are 2'-F
            modified
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```
   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 17:
GGGAGGACGA UGCGGAACAC CCCGGUCUGA CGCUUGUUCC GAAUUCCUCC      50
ACCGUCAGAC GACUCGCCCG A                                     71
```

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(2)   INFORMATION FOR SEQ ID NO: 18:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:   72 base pairs
      (B)   TYPE:   nucleic acid
      (C)   STRANDEDNESS:   single
      (D)   TOPOLOGY:   linear
   (ii)  MOLECULAR TYPE:   RNA
   (ix)  FEATURE:
      (D)   OTHER INFORMATION:   All pyrimidines are 2'-F
            modified
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   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 18:
GGGAGGACGA UGCGGAACAC CCCCGGUUUG ACGCUUGUUC CGAAAUCCUC      50
CACCGUCAGA CGACUCGCCC GA                                    72
```

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(2)   INFORMATION FOR SEQ ID NO: 19:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:   71 base pairs
      (B)   TYPE:   nucleic acid
      (C)   STRANDEDNESS:   single
      (D)   TOPOLOGY:   linear
```

    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 19:
GGGAGGACGA UGCGGAACAC CCCCGGUCUG ACGCUUGUUC CGAAUCCUCC   50
ACCGUCAGAC GACUCGCCCG A   71

(2)   INFORMATION FOR SEQ ID NO: 20:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 70 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 20:
GGGAGGACGA UGCGGGGUUC CUGUUCUACU UUCUAAUUAU CCGCACCUCC   50
UCCUCAGACG ACUCGCCCGA   70

(2) INFORMATION FOR SEQ ID NO: 21:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 21:
GGGAGGACGA UGCGGUGGAG UUUUAAUCUU ACUUCCUACU CUUGCUCCAC   50
UGGGUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 22:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 22:
GGGAGGACGA UGCGGGAUUC AUUUUGAUCU UUCUUUCUCU UAUCCCGCUG   50
UGCCUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 23:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 72 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 23:
GGGAGGACGA UGCGGAUUCC UUUUUCCUUU CUCUUUUCUG ACCGACUGAU   50
CCGCCUCAGA CGACUCGCCC GA   72

(2) INFORMATION FOR SEQ ID NO: 24:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 75 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 24:
GGGAGGACGA UGCGGUAAUC UACACUUAUA UUUUUUUUCU UUUUCUUUCC   50
ACCCAUCGUC AGACGACUCG CCCGA   75

(2) INFORMATION FOR.SEQ ID NO:25:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 25:
GGGAGGACGA UGCGGAGGGU UGGGAGGGGU CCUUCUUUUC GUCUGCGUGG   50
ACCGUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 26:

     (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
     (ii) MOLECULAR TYPE: RNA
     (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

     (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 26:
GGGAGGACGA UGCGGCAUCC CUAGAGCAGC CAGCCGGAAA GAAGUCACGC   50
CUGCUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 27:
     (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
     (ii) MOLECULAR TYPE: RNA
     (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

     (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 27:
GGGAGGACGA UGCGGUAGUG ACCGUCAGGU AGGUGGGUUA GGCCAUUACG   50
UACGUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 28:
     (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 70 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
     (ii) MOLECULAR TYPE: RNA
     (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

     (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 28:
GGGAGGACGA UGCGGGUGCC AACAAUGGAG GUCGGGUUAG GUAAGCCAAC   50
GGGUCAGACG ACUCGCCCGA   70

(2) INFORMATION FOR SEQ ID NO: 29:
     (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 70 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear

```
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 29:
GGGAGGACGA UGCGGUAGUA GCGCGAUAUA GCGCUGGUAG GGUUGCCGGU          50
GGAUCAGACG ACUCGCCCGA                                          70


(2)   INFORMATION FOR SEQ ID NO: 30:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  69 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 30:
GGGAGGACGA UGCGGUAGUA GCGCGAUAUA GCGCUGGUAG GGUAGCCGGU          50
GAUCAGACGA CUCGCCCGA                                           69


(2)   INFORMATION FOR SEQ ID NO: 31:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  70 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 31:
GGGAGGACGA UGCGGUUGUA GCGCGAUAUA GCGCUGGUAG GGUUGCCGGU          50
GGAUCAGACG ACUCGCCCGA                                          70


(2)   INFORMATION FOR SEQ ID NO: 32:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  69 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified
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(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 32:
GGGAGGACGA UGCGGUGGUA GCGCGAUAUA GCGCUGGUAG GGUAGCCGGU   50
GAUCAGACGA CUCGCCCGA   69

(2) INFORMATION FOR SEQ ID NO: 33:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 69 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
         modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 33:
GGGAGGACGA UGCGGUGGUA GCGCGAUAUA GCGCUGGUAG GGUUGCCGGU   50
GAUCAGACGA CUCGCCCGA   69

(2) INFORMATION FOR SEQ ID NO: 34:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 69 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
         modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 34:
GGGAGGACGA UGCGGUUGUA GCGCGAUAUA GCGCUGGUAG GGUUGCCGGU   50
GAUCAGACGA CUCGCCCGA   69

(2) INFORMATION FOR SEQ ID NO: 35:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 70 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
         modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 35:
GGGAGGACGA UGCGGUGGUA GCGCGAUAUA GCGCUGGUAG GGUUGCCGGU   50
GGGUCAGACG ACUCGCCCGA   70

(2) INFORMATION FOR SEQ ID NO: 36:

   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 70 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-NH_2
        modified

  (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 36:
GGGAGGACGA UGCGGUUGUA GCGCGAUAUA GCGCUGGCAG GGUUGCCGGU   50
GGGUCAGACG ACUCGCCCGA   70

(2) INFORMATION FOR SEQ ID NO: 37:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 70 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-NH_2
        modified

  (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 37:
GGGAGGACGA UGCGGUGGCA GCGCGAGAUA GCGCUGGUAG GGUUGCCGGU   50
GGAUCAGACG ACUCGCCCGA   70

(2) INFORMATION FOR SEQ ID NO: 38:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 69 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-NH_2
        modified

  (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 38:
GGGAGGACGA UGCGGUGGUA GCGCGACAUA GCGCUGGUAG GGUUGCCGGU   50
GAUCAGACGA CUCGCCCGA   69

(2) INFORMATION FOR SEQ ID NO: 39:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 71 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear

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    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 39:
GGGAGGACGA UGCGGAAGUG GUGAUCCCAU CUAGGGGUCG GUUGGGUCGA      50
CGGUGCAGAC GACUCGCCCG A                                     71


(2)  INFORMATION FOR SEQ ID NO: 40:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  72 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 40:
GGGAGGACGA UGCGGUGUGU GGGGUGCCAU AUAACCCCGG UUGGGUUGAC      50
GGUGUCAGAG CGACUCGCCC GA                                    72


(2)  INFORMATION FOR SEQ ID NO: 41:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  70 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 41:
GGGAGGACGA UGCGGUAGUG CUCACAGAGC GGUUGGGUAG CCGGUGGAUG      50
CGGUCAGACG ACUCGCCCGA                                       70


(2)  INFORMATION FOR SEQ ID NO: 42:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  71 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified
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(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 42:
GGGAGGACGA UGCGGUGUGG UGCAAUCUAA GCACCGGUUG GGUAGUUCGG   50
UGGCUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO:43:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
           modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 43:
GGGAGGACGA UGCGGAGGCU CAAAAGGCCG GUUGGGUUAG GUAACUGUGU   50
GCGGUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 44:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 67 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
           modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 44:
GGGAGGACGA UGCGGUAUGG UGGGUUUACG CGAGAGUAAG GGUCGCGUGG   50
UCAGACGACU CGCCCGA   67

(2) INFORMATION FOR SEQ ID NO: 45:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 71 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
           modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 45:
GGGAGGACGA UGCGGACGUA UGGUGGGUUC GUAGUAUUGG GCUCGUAGCG   50
UGGGUCAGAC GACUCGCCCG A   71

(2) INFORMATION FOR SEQ ID NO: 46:

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    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  70 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH$_2$
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 46:
GGGAGGACGA UGCGGCAGGU AAUUACAUGA AGGUGGGUUA GGUACUUUCA        50
GGGUCAGACG ACUCGCCCGA                                         70


(2)  INFORMATION FOR SEQ ID NO: 47:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  70 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH$_2$
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 47:
GGGAGGACGA UGCGGUAGGU AAUUACAUGA AGGUGGGUUA GGUACUUUCA        50
GGGUCAGACG ACUCGCCCGA                                         70


(2)  INFORMATION FOR SEQ ID NO: 48:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  71 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH$_2$
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 48:
GGGAGGACGA UGCGGCAGUA AAUUCGGUAG GUGGGUUAGG UAGGAUCGUG        50
AGGGUCAGAC GACUCGCCCG A                                       71


(2)  INFORMATION FOR SEQ ID NO: 49:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  71 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
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     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO:49:
GGGAGGACGA UGCGGUAUGG UGGGUUGCAC GUAUUAAGGG ACGUACAUCU        50
GUGCUCAGAC GACUCGCCCG A                                       71

(2)  INFORMATION FOR SEQ ID NO: 50:
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  77 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 50:
GGGAGGACGA UGCGGUAUAG GUAACUAUCA GGUGGGUAGU CGGUGGAAAC        50
GGGCUGUUGG UCAGACGACU CGCCCGA                                 77

(2)  INFORMATION FOR SEQ ID NO: 51:
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  71 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 51:
GGGAGGACGA UGCGGUACAG GUGGGUCGUG GAUAAUUGGG CACGCUCUAU        50
CUCCUCAGAC GACUCGCCCG A                                       71

(2)  INFORMATION FOR SEQ ID NO: 52:
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH: 71 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
            modified
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      (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 52:
GGGAGGACGA UGCGGCACUA GGUGGGUCGU GGUUGUUGGG CACGUAACUU        50
CGCGUCAGAC GACUCGCCCG A                                       71


      (2)  INFORMATION FOR SEQ ID NO: 53:
         (i)  SEQUENCE CHARACTERIZATION:
            (A)  LENGTH:  71 base pairs
            (B)  TYPE:  nucleic acid
            (C)  STRANDEDNESS:  single
            (D)  TOPOLOGY:  linear
        (ii)  MOLECULAR TYPE:  RNA
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH2
                 modified


      (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 53:
GGGAGGACGA UGCGGUACUA GGUGGGUCGU GGUUGUUGGG CACGUAACUU        50
CGCGUCAGAC GACUCGCCCG A                                       71


      (2)  INFORMATION FOR SEQ ID NO: 54:
         (i)  SEQUENCE CHARACTERIZATION:
            (A)  LENGTH: 71 base pairs
            (B)  TYPE:  nucleic acid
            (C)  STRANDEDNESS:  single
            (D)  TOPOLOGY:  linear
        (ii)  MOLECULAR TYPE:  RNA
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH2
                 modified


      (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 54:
GGGAGGACGA UGCGGACGUG GCCUUAGAUA GGCAGGUGGG UUAGGCAUAU        50
UCAGUCAGAC GACUCGCCCG A                                       71


      (2)  INFORMATION FOR SEQ ID NO: 55:
         (i)  SEQUENCE CHARACTERIZATION:
            (A)  LENGTH:  70 base pairs
            (B)  TYPE:  nucleic acid
            (C)  STRANDEDNESS:  single
            (D)  TOPOLOGY:  linear
        (ii)  MOLECULAR TYPE:  RNA
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH2
                 modified


      (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 55:
GGGAGGACGA UGCGGUUCGC GGCCUAAUUA AAGGCAGGAG GGUUAGGCAU        50
UGCUCAGACG ACUCGCCCGA                                         70


      (2)  INFORMATION FOR SEQ ID NO: 56:
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        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 70 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear
        (ii) MOLECULAR TYPE: RNA
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
               modified

        (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 56:
GGGAGGACGA UGCGGUGACU ACGCCUGUAG UAGGUCGGGU UAGGCAUUGG   50
GCGUCAGACG ACUCGCCCGA   70

    (2)   INFORMATION FOR SEQ ID NO: 57:
        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 70 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear
        (ii) MOLECULAR TYPE: RNA
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
               modified

        (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 57:
GGGAGGACGA UGCGGUGCGC AAUUGCGCAG GUCGGGUUAG GUAUCUGGGU   50
AGCUCAGACG ACUCGCCCGA   70

    (2)   INFORMATION FOR SEQ ID NO: 58:
        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 73 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear
        (ii) MOLECULAR TYPE: RNA
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All U's are 2'-NH$_2$ modified
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All C's are 2'-F modified

        (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 58:
GGGAGGACGA UGCGGUUCAG AGGGUAGGUA AGUGGGAGGA AAAAUGCCGU   50
AUCGCCUCAG ACGACUCGCC CGA   73

    (2)   INFORMATION FOR SEQ ID NO: 59:
        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 71 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single

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  (D)  TOPOLOGY:  linear
(ii)  MOLECULAR TYPE:  RNA
(ix)  FEATURE:
  (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
(ix)  FEATURE:
  (D)  OTHER INFORMATION:  All C's are 2'-F modified


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 59:
GGGAGGACGA UGCGGAGGUA AGAGGGAGGG ACCUUCCAGU GAAUGUGCGC      50
GUGGUCAGAC GACUCGCCCG A                                     71


(2)  INFORMATION FOR SEQ ID NO: 60:
  (i)  SEQUENCE CHARACTERIZATION:
   (A)  LENGTH:  71 base pairs
   (B)  TYPE:  nucleic acid
   (C)  STRANDEDNESS:  single
   (D)  TOPOLOGY:  linear
 (ii)  MOLECULAR TYPE:  RNA
 (ix)  FEATURE:
   (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
 (ix)  FEATURE:
   (D)  OTHER INFORMATION:  All C's are 2'-F modified


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 60:
GGGAGGACGA UGCGGAGGCC UGUGGUGAGG AUUGUGGGUG GUUGGCCACG      50
CGCGUCAGAC GACUCGCCCG A                                     71


(2)  INFORMATION FOR SEQ ID NO: 61:
  (i)  SEQUENCE CHARACTERIZATION:
   (A)  LENGTH: 71 base pairs
   (B)  TYPE:  nucleic acid
   (C)  STRANDEDNESS:  single
   (D)  TOPOLOGY:  linear
 (ii)  MOLECULAR TYPE:  RNA
 (ix)  FEATURE:
   (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
 (ix)  FEATURE:
   (D)  OTHER INFORMATION:  All C's are 2'-F modified


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 61:
GGGAGGACGA UGCGGUCCAA AGAGGGUGGU UGUGGGUGGC ACUAAGGUAC      50
CGCGUCAGAC GACUCGCCCG A                                     71


(2)  INFORMATION FOR SEQ ID NO: 62:
  (i)  SEQUENCE CHARACTERIZATION:
   (A)  LENGTH: 70 base pairs
   (B)  TYPE:  nucleic acid
   (C)  STRANDEDNESS:  single
   (D)  TOPOLOGY:  linear
 (ii)  MOLECULAR TYPE:  RNA
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     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All C's are 2'-F modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 62:
GGGAGGACGA UGCGGUAUUC GUAAGGCCAG AGCUGCGGGU GGGACCUCCG       50
GCCUCAGACG ACUCGCCCGA                                         70


  (2)  INFORMATION FOR SEQ ID NO: 63:
     (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH:  70 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All C's are 2'-F modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 63:
GGGAGGACGA UGCGGCCAUA GUGGGUGGGU UUGGAGUGGA AUAGUGCCGA       50
GCGUCAGACG ACUCGCCCGA                                         70


  (2)  INFORMATION FOR SEQ ID NO: 64:
     (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH:  71 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All C's are 2'-F modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 64:
GGGAGGACGA UGCGGUGCAC AUGAGGGUGG UGUGGGAGGA AACGUGACGC       50
AUGGUCAGAC GACUCGCCCG A                                       71

  (2)  INFORMATION FOR SEQ ID NO: 65:
     (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH: 71 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
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   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All C's are 2'-F modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 65:
GGGAGGACGA UGCGGUUCCG UCCGUGGGAU AGGUUUGUGG GAUGUACCGG        50
CUGGUCAGAC GACUCGCCCG A                                       71


(2)  INFORMATION FOR SEQ ID NO: 66:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  59 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 66:
GGGAGGACGA UGCGGACACC GUUAAUCUGA GGCCCUGUCC UAUUCCUUCA        50
CGCCUCAGA                                                     59


(2)  INFORMATION FOR SEQ ID NO: 67:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  46 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 67:
GUUUUAAUCU UACUUCCUAC UCUUGCUCCA CUGGGUCAGA CGACUC            46


(2)  INFORMATION FOR SEQ ID NO: 68:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  57 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 68:
GGGAGGACGA UGCGGCAUCC CUAGAGCAGC CAGCCGGAAA GAAGUCACGC        50
CUGCUCA                                                       57
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(2)   INFORMATION FOR SEQ ID NO: 69:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 64 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-F
          modified

  (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 69:
GGGAGGACGA UGCGGAACAC CCCCGGUCUG ACGCUUGUUC CGAAUUCCUC   50
CACCGUCAGA CGAC   64

(2)   INFORMATION FOR SEQ ID NO: 70:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 37 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-F
          modified

  (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 70:
GGGAGGACGA UGCGGAGGGU UGGGAGGGGU CCUUCUU   37

(2)   INFORMATION FOR SEQ ID NO: 71:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 51 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are $2'-NH_2$
          modified

  (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 71:
GGGAGGACGA UGCGGUGGUA GCGCGAUAUA GCGCUGGUAG GGUUGCCGGU   50
G   51

(2)   INFORMATION FOR SEQ ID NO: 72:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 44 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear

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    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH2
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 72:
GGGAGGACGA UGCGGCAGGU AAUUACAUGA AGGUGGGUUA GGUA              44


(2)  INFORMATION FOR SEQ ID NO: 73:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  50 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH2 modified
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 73:
GGACGAUGCG GUUCAGAGGG UAGGUAAGUG GGAGGAAAAA UGCCGUAUCG        50


(2)  INFORMATION FOR SEQ ID NO: 74:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 74:
GGGAGACAAG AATAAACGCT CAANNNNNNN NNNNNNNNNN NNNNNNNNNN        50
NNNNNNNNNN NNNTTCGACA GGAGGCTCAC AACAGGC                     87


(2)  INFORMATION FOR SEQ ID NO: 75:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  40 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 75:
TAATACGACT CACTATAGGG AGACAAGAAT AAACGCTCAA                   40


(2)  INFORMATION FOR SEQ ID NO: 76:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  24 base pairs
      (B)  TYPE:  nucleic acid
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    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
 (ii)  MOLECULAR TYPE:  DNA


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 76:
GCCTGTTGTG AGCCTCCTGT CGAA                              24


(2)  INFORMATION FOR SEQ ID NO: 77:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  49 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)  MOLECULAR TYPE:  DNA


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 77:
CCGAAGCTTT AATACGACTC ACTATAGGGA GACAAGAATA AACGCTCAA     49


(2)  INFORMATION FOR SEQ ID NO: 78:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  33 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)  MOLECULAR TYPE:  DNA


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 78:
GCCGGATCCG CCTGTTGTGA GCCTCCTGTC GAA                     33


(2)  INFORMATION FOR SEQ ID NO: 79:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)  MOLECULAR TYPE:  RNA
  (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
         modified


 (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 79:
GGGAGACAAG AAUAAACGCU CAACUAUGGG GAGCCACAUU AACGGCAAUA     50
AAUCAUUACG ACUUCGACAG GAGGCUCACA ACAGGC                  86


(2)  INFORMATION FOR SEQ ID NO: 80:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  89 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
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    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 80:
GGGAGACAAG AAUAAACGCU CAACUAUGGG GAGCCACAUU UAACGGCUAU        50
AAAAAACAUU ACGACUUCGA CAGGAGGCUC ACAACAGGC                   89


(2)   INFORMATION FOR SEQ ID NO: 81:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  86 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 81:
GGGAGACAAG AAUAAACGCU CAACUCGGGA GCCAGAGUAA CAACGGCAUU        50
AUAUAAUUUA CUUUCGACAG GAGGCUCACA ACAGGC                      86


(2)   INFORMATION FOR SEQ ID NO: 82:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  87 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 82:
GGGAGACAAG AAUAAACGCU CAAUCCCACC GGGGUGCCAC GGUUUAAACG        50
GCUUAAUAUG AAUUUCGACA GGAGGCUCAC AACAGGC                     87

(2)   INFORMATION FOR SEQ ID NO: 83:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  85 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified
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     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 83:
GGGAGACAAG AAUAAACGCU CAAGUCUGAC UAUUGGGGCG CCACAAUAUC      50
AACGGCUGUA CUUCGACAGG AGGCUCACAA CAGGC                      85


(2)  INFORMATION FOR SEQ ID NO: 84:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  88 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 84:
GGGAGACAAG AAUAAACGCU CAAUCCCACC GGGGUGCCAC GGUUUAAACG      50
GCUUAAUAUU UACUUUCGAC AGGAGGCUCA CAACAGGC                   88


(2)  INFORMATION FOR SEQ ID NO: 85:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 85:
GGGAGACAAG AAUAAACGCU CAAGUCUUCC AUGGGGAGCC ACAUUAACGG      50
CGCAAUACUG AACUUCGACA GGAGGCUCAC AACAGGC                    87


(2)  INFORMATION FOR SEQ ID NO: 86:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 86:
GGGAGACAAG AAUAAACGCU CAACUCGGGA GCCAGAGUAA CAACGGCACU      50
AUAUAAUUUU ACUUUCGACA GGAGGCUCAC AACAGGC                    87


(2)  INFORMATION FOR SEQ ID NO: 87:
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(i)   SEQUENCE CHARACTERIZATION:
   (A)  LENGTH:  87 base pairs
   (B)  TYPE:  nucleic acid
   (C)  STRANDEDNESS:  single
   (D)  TOPOLOGY:  linear
(ii)  MOLECULAR TYPE:  RNA
(ix)  FEATURE:
   (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
        modified


(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 87:
GGGAGACAAG AAUAAACGCU CAACUAUGGG GAGCCACAUU UAACGGCAAU        50
AAAUCAUUAC GACUUCGACA GGAGGCUCAC AACAGGC                     87


(2)  INFORMATION FOR SEQ ID NO: 88:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 88:
GGGAGACAAG AAUAAACGCU CAAAGUGGGG AGCCACACUA AAACGGCAUA        50
UUGACAUCGU CCCUUCGACA GGAGGCUCAC AACAGGC                     87


(2)  INFORMATION FOR SEQ ID NO: 89:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  88 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 89:
GGGAGACAAG AAUAAACGCU CAAUCUCCUC AUGGGGCGCC ACAUGGUUUU        50
AACGGCAUAU CACUUUCGAC AGGAGGCUCA CAACAGGC                    88


(2)  INFORMATION FOR SEQ ID NO: 90:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
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    (ii)   MOLECULAR TYPE: RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION: All pyrimidines are 2'-F
         modified

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 90:
GGGAGACAAG AAUAAACGCU CAACUAUGGG GAGCCACAUU UAACGGCUAU   50
AAAUCAUUAC GACUUCGACA GGAGGCUCAC AACAGGC   87

(2)   INFORMATION FOR SEQ ID NO: 91:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 87 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION: All pyrimidines are 2'-F
         modified

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 91:
GGGAGACAAG AAUAAACGCU CAAACUGGGG AGCCACAGAU UUAACGGCGC   50
AUAUGAGUUG AGCUUCGACA GGAGGCUCAC AACAGGC   87

(2)   INFORMATION FOR SEQ ID NO: 92:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 86 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION: All pyrimidines are 2'-F
         modified

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 92:
GGGAGACAAG AAUAAACGCU CAACUCUCAC UGGGGAGCCA CAGUUUUAAA   50
CGGCAAGGGA GAUUCGACAG GAGGCUCACA ACAGGC   86

(2)   INFORMATION FOR SEQ ID NO: 93:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 84 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: RNA
    (ix)   FEATURE:
      (D)   OTHER INFORMATION: All pyrimidines are 2'-F
         modified

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(xi)  SEQUENCE DESCRIPTION: SEQ ID NO: 93:
GGGAGACAAG AAUAAACGCU CAACAUCAGA UGGGGUGCCA CAUCAUCAAA        50
CGGCUAUAUA UUCGACAGGA GGCUCACAAC AGGC                         84


(2)  INFORMATION FOR SEQ ID NO: 94:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  86 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 94:
GGGAGACAAG AAUAAACGCU CAAACUGGGG AGCCACAGAU UUAACGGCAC        50
AUAUGAUUGA GCUUCGACAG GAGGCUCACA ACAGGC                       86


(2)  INFORMATION FOR SEQ ID NO: 95:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  89 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 95:
GGGAGACAAG AAUAAACGCU CAAAACGGCU GUAACAAACA AGGUGGGGGG        50
CCACACCAGA GCGGCUUCGA CAGGAGGCUC ACAACAGGC                    89


(2)  INFORMATION FOR SEQ ID NO: 96:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  93 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 96:
GGGAGACAAG AAUAAACGCU CAAACGGCUG UAACAAACAA GGUGGGGGGC        50
CACACAGAGC GGGUUCGACU UCGACAGGAG GCUCACAACA GGC               93


(2)  INFORMATION FOR SEQ ID NO: 97:
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    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 97:
GGGAGACAAG AAUAAACGCU CAAACGGCUG UGACAAACAA GGUGGGGGGC      50
CACACAGAGC GGGUUCGACA GGAGGCUCAC AACAGGC                    87


 (2)  INFORMATION FOR SEQ ID NO: 98:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  86 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 98:
GGGAGACAAG AAUAAACGCU CAAAUAGCAG AGCCCAUGGC GGGAGGGAGG      50
AUUGUGGUGG AAUUCGACAG GAGGCUCACA ACAGGC                     86


 (2)  INFORMATION FOR SEQ ID NO: 99:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 99:
GGGAGACAAG AAUAAACGCU CAACAUCGAC GGACCAGAGG UAGUGGGGGG      50
GAUGGGAUGC CCGUUCGACA GGAGGCUCAC AACAGGC                    87


 (2)  INFORMATION FOR SEQ ID NO: 100:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
```

```
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 100:
GGGAGACAAG AAUAAACGCU CAAACCUAAC AUCUUACCAU AUUCAAUUUA      50
CAUUACACAC UAUUUCGACA GGAGGCUCAC AACAGGC                    87

(2)  INFORMATION FOR SEQ ID NO: 101:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  86 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 101:
GGGAGACAAG AAUAAACGCU CAAGCUGCCC AAGGAAUUUA ACUUGGACCG      50
CGAUCUGGAG UCUUCGACAG GAGGCUCACA ACAGGC                    86

(2)  INFORMATION FOR SEQ ID NO: 102:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  87 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 102:
GGGAGACAAG AAUAAACGCU CAAAGGAGCG CCAUGAAGCA AAGGGAGGAU      50
UGUGGUGGAA GGCUUCGACA GGAGGCUCAC AACAGGC                    87

(2)  INFORMATION FOR SEQ ID NO: 103:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  80 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified
```

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 103:

GGGAGACAAG AAUAAACGCU CAACCGUAUU AACACUUAUU UUACAAUUUU   50
UUCAUAUUCG ACAGGAGGCU CACAACAGGC   80

(2) INFORMATION FOR SEQ ID NO: 104:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-F
      modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 104:

GGGAGACAAG AAUAAACGCU CAAGGUACGA CCAAGGAAUG UGGGUGGAAG   50
AGGGUGCCGU ACCUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 105:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-F
      modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 105:

GGGAGACAAG AAUAAACGCU CAAGACGAAC GACCACGGGA UGGGUGGGCA   50
AAUAGGGAUG CCGUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 106:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-F
      modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 106:

GGGAGACAAG AAUAAACGCU CAAGCUAACC CGUACAAAUU UUCUUUUUCA   50
UUUUCAUCAC UAUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 107:

    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 87 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 107:
GGGAGACAAG AAUAAACGCU CAACUCGGGA GCCAGAGUAA CAACGGCACU   50
AUAUAAUUUU ACCUUCGACA GGAGGCUCAC AACAGGC   87

  (2) INFORMATION FOR SEQ ID NO: 108:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 85 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 108:
GGGAGACAAG AAUAAACGCU CAACGACCCG ACCAAGGGUA GGCAUGUGGG   50
GGGGUGCCGG GUUCGACAGG AGGCUCACAA CAGGC   85

  (2) INFORMATION FOR SEQ ID NO: 109:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 87 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
           modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 109:
GGGAGACAAG AAUAAACGCU CAAUCCGAAC AUGGGGUGCC ACAAAAACGG   50
CUAUUAUCAC UAUUUCGACA GGAGGCUCAC AACAGGC   87

  (2) INFORMATION FOR SEQ ID NO: 110:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 87 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear

```
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
       (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
             modified
```

```
    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 110:
GGGAGACAAG AAUAAACGCU CAAGGACUGG UGAGCCACGU AUACGGUCUU      50
AGGGGCUUGG GCGUUCGACA GGAGGCUCAC AACAGGC                    87
```

```
(2)   INFORMATION FOR SEQ ID NO: 111:
    (i)    SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  87 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
       (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
             modified
```

```
    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 111:
GGGAGACAAG AAUAAACGCU CAACCUUGUG GGGAGCCACG UAUACGGCCA      50
UAGCAUACCG CAAUUCGACA GGAGGCUCAC AACAGGC                    87
```

```
(2)   INFORMATION FOR SEQ ID NO: 112:
    (i)    SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  87 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
       (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
             modified
```

```
    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 112:
GGGAGACAAG AAUAAACGCU CAAGAGCUGG UGAGCCACGU AUACGGCCUU      50
AGGGGCUUGG GCGUUCGACA GGAGGCUCAC AACAGGC                    87
```

```
(2)   INFORMATION FOR SEQ ID NO: 113:
    (i)    SEQUENCE CHARACTERIZATION:
       (A)   LENGTH:  87 base pairs
       (B)   TYPE:  nucleic acid
       (C)   STRANDEDNESS:  single
       (D)   TOPOLOGY:  linear
    (ii)   MOLECULAR TYPE:  RNA
    (ix)   FEATURE:
       (D)   OTHER INFORMATION:  All pyrimidines are 2'-NH₂
             modified
```

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 113:
GGGAGACAAG AAUAAACGCU CAAGAGCUGG UGAGCCACGU AUACGGUCUU   50
AGGGGCUUGG GCGUUCGACA GGAGGCUCAC AACAGGC   87

    (2) INFORMATION FOR SEQ ID NO: 114:
      (i) SEQUENCE CHARACTERIZATION:
        (A) LENGTH: 87 base pairs
        (B) TYPE: nucleic acid
        (C) STRANDEDNESS: single
        (D) TOPOLOGY: linear
      (ii) MOLECULAR TYPE: RNA
      (ix) FEATURE:
        (D) OTHER INFORMATION: All pyrimidines are $2'-NH_2$
             modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 114:
GGGAGACAAG AAUAAACGCU CAAGUAUUGG GGAGCCACAU UACAACGGCA   50
CAGGCAACCA GGGUUCGACA GGAGGCUCAC AACAGGC   87

    (2) INFORMATION FOR SEQ ID NO: 115:
      (i) SEQUENCE CHARACTERIZATION:
        (A) LENGTH: 87 base pairs
        (B) TYPE: nucleic acid
        (C) STRANDEDNESS: single
        (D) TOPOLOGY: linear
      (ii) MOLECULAR TYPE: RNA
      (ix) FEATURE:
        (D) OTHER INFORMATION: All pyrimidines are $2'-NH_2$
             modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 115:
GGGAGACAAG AAUAAACGCU CAAGUGCUGG UGAGCCACGC AUACGGUCUU   50
AGGGGCUUGA GCGUUCGACA GGAGGCUCAC AACAGGC   87

    (2) INFORMATION FOR SEQ ID NO: 116:
      (i) SEQUENCE CHARACTERIZATION:
        (A) LENGTH: 86 base pairs
        (B) TYPE: nucleic acid
        (C) STRANDEDNESS: single
        (D) TOPOLOGY: linear
      (ii) MOLECULAR TYPE: RNA
      (ix) FEATURE:
        (D) OTHER INFORMATION: All pyrimidines are $2'-NH_2$
             modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 116:
GGGAGACAAG AAUAAACGCU CAAUAAAUGG AGAGCCACAC UAACGGCGUA   50
UGAAAACACU CAUUCGACAG GAGGCUCACA ACAGGC   86

    (2) INFORMATION FOR SEQ ID NO: 117:

        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 86 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear
        (ii) MOLECULAR TYPE: RNA
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All pyrimidines are $2'-NH_2$
               modified

        (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 117:
GGGAGACAAG AAUAAACGCU CAAUCACAAG CACCCUUGGG GAGCCACAUU   50
AACGGCCUAG GCUUCGACAG GAGGCUCACA ACAGGC   86

   (2)   INFORMATION FOR SEQ ID NO: 118:
        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 86 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear
        (ii) MOLECULAR TYPE: RNA
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All pyrimidines are $2'-NH_2$
               modified

        (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 118:
GGGAGACAAG AAUAAACGCU CAAAUGGAGA GCCACAUUAA CGGCAGCAUA   50
UCACAGUAGG AAUUCGACAG GAGGCUCACA ACAGGC   86

   (2)   INFORMATION FOR SEQ ID NO: 119:
        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 85 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear
        (ii) MOLECULAR TYPE: RNA
        (ix) FEATURE:
         (D)   OTHER INFORMATION: All pyrimidines are $2'-NH_2$
               modified

        (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 119:
GGGAGACAAG AAUAAACGCU CAAUGUGGGG AGCCACAGUU AACGGCUUCA   50
ACUGAUUAGA AUUCGACAGG AGGCUCACAA CAGGC   85

   (2)   INFORMATION FOR SEQ ID NO: 120:
        (i)   SEQUENCE CHARACTERIZATION:
         (A)   LENGTH: 87 base pairs
         (B)   TYPE: nucleic acid
         (C)   STRANDEDNESS: single
         (D)   TOPOLOGY: linear

```
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 120:
GGGAGACAAG AAUAAACGCU CAAAGAUUUA AAGUAUUUGG GGAGCCACAU          50
CAACGGCAUU GUGUUCGACA GGAGGCUCAC AACAGGC                        87

(2)  INFORMATION FOR SEQ ID NO: 121:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 121:
GGGAGACAAG AAUAAACGCU CAAUGACUGA ACGAUGGUAU UGGAGAGCCA          50
CAUCAACGGC AAUUUCGACA GGAGGCUCAC AACAGGC                        87

(2)  INFORMATION FOR SEQ ID NO: 122:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  86 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 122:
GGGAGACAAG AAUAAACGCU CAACAGAUGG UAUCUAGUGG AGAGCCACAU          50
CAACGGCGCA GAUUCGACAG GAGGCUCACA ACAGGC                         86

(2)  INFORMATION FOR SEQ ID NO: 123:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified
```

```
  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 123:
GGGAGACAAG AAUAAACGCU CAACGAUAGU AUACACAUGA UGAUGGGGAG        50
CCACGUGUAC GGCUUCGACA GGAGGCUCAC AACAGGC                      87
```

(2) INFORMATION FOR SEQ ID NO: 124:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are $2'$-NH_2
       modified

```
  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 124:
GGGAGACAAG AAUAAACGCU CAACGAUGGA GCGCCACAUC GCUAUAACGG        50
CAUUUAACAA AAUUUCGACA GGAGGCUCAC AACAGGC                      87
```

(2) INFORMATION FOR SEQ ID NO: 125:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are $2'$-NH_2
       modified

```
  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 125:
GGGAGACAAG AAUAAACGCU CAAGCGGUCU GAUUGAGCCA CCGUGGAGGG        50
UACGUGGAGG GAUUCGACAG GAGGCUCACA ACAGGC                       86
```

(2) INFORMATION FOR SEQ ID NO: 126:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are $2'$-NH_2
       modified

```
  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 126:
GGGAGACAAG AAUAAACGCU CAAACAAUUU CACACAGAAA CAGCUAUGAC        50
CAUGAUUACG CCAUUCGACA GGAGGCUCAC AACAGGC                      87
```

(2) INFORMATION FOR SEQ ID NO: 127:

130

```
(i)   SEQUENCE CHARACTERIZATION:
  (A)  LENGTH:  87 base pairs
  (B)  TYPE:  nucleic acid
  (C)  STRANDEDNESS:  single
  (D)  TOPOLOGY:  linear
(ii)  MOLECULAR TYPE:  RNA
(ix)  FEATURE:
  (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
       modified
```

$$2'\text{-NH}_2$$

```
(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 127:
GGGAGACAAG AAUAAACGCU CAAAGCUUUG GGGAGCCACA UAUAACGGCA          50
UGAUCAAAUA UAGUUCGACA GGAGGCUCAC AACAGGC                       87
```

```
(2)  INFORMATION FOR SEQ ID NO: 128:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  87 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)  MOLECULAR TYPE:  RNA
  (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
         modified
```

```
(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 128:
GGGAGACAAG AAUAAACGCU CAAAUACAAU GUGGUUGAAG CUACCUCCCA          50
CUCGUAGUGG GCCUUCGACA GGAGGCUCAC AACAGGC                       87
```

```
(2)  INFORMATION FOR SEQ ID NO: 129:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)  MOLECULAR TYPE:  RNA
  (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
         modified
```

```
(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 129:
GGGAGACAAG AAUAAACGCU CAACCGUAGC CUCCAGCGGA ACGCGGAGGG          50
UACGUGGAGG GGUUCGACAG GAGGCUCACA ACAGGC                        86
```

```
(2)  INFORMATION FOR SEQ ID NO: 130:
  (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
```

(ii) MOLECULAR TYPE: RNA
(ix) FEATURE:
  (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
      modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 130:
GGGAGACAAG AAUAAACGCU CAACCGUAGC CUCCAGCGGA AUGCGGAGGG   50
CACGUGGAGG GGUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 131:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 85 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
        modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 131:
GGGAGACAAG AAUAAACGCU CAAGAGCCUC CGUGAAUGAC GUGGAGGCAC   50
GCGGAGGGGA AUUCGACAGG AGGCUCACAA CAGGC   85

(2) INFORMATION FOR SEQ ID NO: 132:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
        modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 132:
GGGAGACAAG AAUAAACGCU CAAUCGAUAC UACUCCUGGA GAAAAGGGAG   50
GACCGUGGAG GAUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 133:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
        modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 133:

GGGAGACAAG AAUAAACGCU CAAUCGAUAC UACUCCUGGA GAAAAGGGAG   50

GAUCGUGGAG GAUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 134:

   (i) SEQUENCE CHARACTERIZATION:

    (A) LENGTH: 86 base pairs

    (B) TYPE: nucleic acid

    (C) STRANDEDNESS: single

    (D) TOPOLOGY: linear

   (ii) MOLECULAR TYPE: RNA

   (ix) FEATURE:

    (D) OTHER INFORMATION: All pyrimidines are $2'$-NH_2
       modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 134:

GGGAGACAAG AAUAAACGCU CAAGCGGUCU GAUUGAGCCU CCGUGGAGGG   50

UACGUGGAGG GAUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 135:

   (i) SEQUENCE CHARACTERIZATION:

    (A) LENGTH: 86 base pairs

    (B) TYPE: nucleic acid

    (C) STRANDEDNESS: single

    (D) TOPOLOGY: linear

   (ii) MOLECULAR TYPE: RNA

   (ix) FEATURE:

    (D) OTHER INFORMATION: All pyrimidines are $2'$-NH_2
       modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 135:

GGGAGACAAG AAUAAACGCU CAAAGGGUGG AUUGUGGAGG AAUGAGUUGU   50

CUAUGGACUC CAUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 136:

   (i) SEQUENCE CHARACTERIZATION:

    (A) LENGTH: 87 base pairs

    (B) TYPE: nucleic acid

    (C) STRANDEDNESS: single

    (D) TOPOLOGY: linear

   (ii) MOLECULAR TYPE: RNA

   (ix) FEATURE:

    (D) OTHER INFORMATION: All pyrimidines are $2'$-NH_2
       modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 136:

GGGAGACAAG AAUAAACGCU CAAUCGAUAC UACUCCUGGA GAAAAGGGAG   50

GAUCGUGGAG GAAUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 137:

133

(i) SEQUENCE CHARACTERIZATION:
  (A) LENGTH: 87 base pairs
  (B) TYPE: nucleic acid
  (C) STRANDEDNESS: single
  (D) TOPOLOGY: linear
(ii) MOLECULAR TYPE: RNA
(ix) FEATURE:
  (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
     modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 137:
GGGAGACAAG AAUAAACGCU CAACCGAUAC UACUCCUGGA GAAAAGGGAG   50
GAUCGUGGAG GAAUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 138:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
       modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 138:
GGGAGACAAG AAUAAACGCU CAAGGGAGGA UAGUGGAGGA AGAGCGUGUA   50
AUAAUGUUAC GAUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 139:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
       modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 139:
GGGAGACAAG AAUAAACGCU CAAUCGUAGC CUCCAGCGGA AUGCGGAGGG   50
CACGUGGAGG GGUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 140:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear

```
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 140:
GGGAGACAAG AAUAAACGCU CAAUCGAUAC UACUCCUGGA GAAAAGGGAG    50
GAUCGUGGAG GAAUUCGACA GGAGGCUCAC AACAGGC                  87

  (2)  INFORMATION FOR SEQ ID NO: 141:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  84 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 141:
GGGAGACAAG AAUAAACGCU CAACCGCAGC CUCCAGCAAU GCGGAGGGCA    50
CGUGGAGGGG UUCGACAGGA GGCUCACAAC AGGC                     84

  (2)  INFORMATION FOR SEQ ID NO: 142:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  86 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 142:
GGGAGACAAG AAUAAACGCU CAAGAGCCUC CGAGAAUGAC GUGGAGGGUA    50
CGUGGAGGGG UAUUCGACAG GAGGCUCACA ACAGGC                   86

  (2)  INFORMATION FOR SEQ ID NO: 143:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  86 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
           modified
```

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(xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 143:
GGGAGACAAG AAUAAACGCU CAACCGUAGC CUCCAGCGGA ACGCGGAGGG   50
CACGUGGAGG GGUUCGACAG GAGGCUCACA ACAGGC   86

(2)   INFORMATION FOR SEQ ID NO: 144:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 86 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
          modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 144:
GGGAGACAAG AAUAAACGCU CAAUGCCGAG AGGAGGGCUG AGGAGGACGC   50
GGCAUUAAGU GAUUCGACAG GAGGCUCACA ACAGGC   86

(2)   INFORMATION FOR SEQ ID NO: 145:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 87 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
          modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 145:
GGGAGACAAG AAUAAACGCU CAAUCGAUAC UACUCCUGGA GAAAAGGGAG   50
GAUCGUGGAG GAUUUCGACA GGAGGCUCAC AACAGGC   87

(2)   INFORMATION FOR SEQ ID NO: 146:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH: 86 base pairs
    (B)   TYPE: nucleic acid
    (C)   STRANDEDNESS: single
    (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D)   OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
          modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 146:
GGGAGACAAG AAUAAACGCU CAAGAGCCUC CGAGAAUGAC GUGGAGGGCA   50
CGUGGAGGGG AAUUCGACAG GAGGCUCACA ACAGGC   86

(2)   INFORMATION FOR SEQ ID NO: 147:

```
   (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)   MOLECULAR TYPE:  RNA
  (ix)   FEATURE:
    (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
         modified
```

(xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 147:

```
GGGAGACAAG AAUAAACGCU CAAUGCUGAG AGGAGGGCUG AGGAGGACAC        50
GGCAGUAUGA GAUUCGACAG GAGGCUCACA ACAGGC                       86
```

(2)   INFORMATION FOR SEQ ID NO: 148:
```
   (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)   MOLECULAR TYPE:  RNA
  (ix)   FEATURE:
    (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
         modified
```

(xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 148:

```
GGGAGACAAG AAUAAACGCU CAAACGUAGC CUCCAGCGGA AUGCGGAGGG        50
CACGUGGAGG GGUUCGACAG GAGGCUCACA ACAGGC                       86
```

(2)   INFORMATION FOR SEQ ID NO: 149:
```
   (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii)   MOLECULAR TYPE:  RNA
  (ix)   FEATURE:
    (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
         modified
```

(xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 149:

```
GGGAGACAAG AAUAAACGCU CAAGCGGUCU GAUCGAGCCU CCGUGGAGGG        50
UACGUGGAGG GAUUCGACAG GAGGCUCACA ACAGGC                       86
```

(2)   INFORMATION FOR SEQ ID NO: 150:
```
   (i)   SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  86 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
```

(ii) MOLECULAR TYPE: RNA
(ix) FEATURE:
  (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
     modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 150:

```
GGGAGACAAG AAUAAACGCU CCAGCGGUCU GAUUGAGCCU CCGUGGAGGG    50
CACGUGGAGG GAUUCGACAG GAGGCUCACA ACAGGC                   86
```


(2) INFORMATION FOR SEQ ID NO: 151:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
     modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 151:

```
GGGAGACAAG AAUAAACGCU CAAUGCCGAG AGGAGGGCUG AGGAGGACAC    50
GGCAGUAUGU AAUUCGACAG GAGGCUCACA ACAGGC                   86
```


(2) INFORMATION FOR SEQ ID NO: 152:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 86 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
     modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 152:

```
GGGAGACAAG AAUAAACGCU CAACCGUAGC CUCCAGCGGA AUGUGGAGGG    50
CACGUGGAGG GGUUCGACAG GAGGCUCACA ACAGGC                   86
```


(2) INFORMATION FOR SEQ ID NO: 153:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 85 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: RNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: All pyrimidines are 2'-NH$_2$
     modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 153:
GGGAGACAAG AAUAAACGCU CAAAAGGUGG GUCGUGGAGG AAUGAGCUCG   50
CUCCCAGCUA AUUCGACAGG AGGCUCACAA CAGGC   85

    (2) INFORMATION FOR SEQ ID NO: 154:
        (i) SEQUENCE CHARACTERIZATION:
        (A) LENGTH: 87 base pairs
        (B) TYPE: nucleic acid
        (C) STRANDEDNESS: single
        (D) TOPOLOGY: linear
      (ii) MOLECULAR TYPE: RNA
      (ix) FEATURE:
        (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
      (ix) FEATURE:
        (D) OTHER INFORMATION: All C's are 2'-F modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 154:
GGGAGACAAG AAUAAACGCU CAAAGAGUGC AGGUCUGGGG CGCCACAAUU   50
ACAACGGCAA UAAUUCGACA GGAGGCUCAC AACAGGC   87

    (2) INFORMATION FOR SEQ ID NO: 155:
        (i) SEQUENCE CHARACTERIZATION:
        (A) LENGTH: 87 base pairs
        (B) TYPE: nucleic acid
        (C) STRANDEDNESS: single
        (D) TOPOLOGY: linear
      (ii) MOLECULAR TYPE: RNA
      (ix) FEATURE:
        (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
      (ix) FEATURE:
        (D) OTHER INFORMATION: All C's are 2'-F modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 155:
GGGAGACAAG AAUAAACGCU CAAGUCUUCC AUGGGGAGCC ACAUUAACGG   50
CGCAAUACUG AACUUCGACA GGAGGCUCAC AACAGGC   87

    (2) INFORMATION FOR SEQ ID NO: 156:
        (i) SEQUENCE CHARACTERIZATION:
        (A) LENGTH: 86 base pairs
        (B) TYPE: nucleic acid
        (C) STRANDEDNESS: single
        (D) TOPOLOGY: linear
      (ii) MOLECULAR TYPE: RNA
      (ix) FEATURE:
        (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
      (ix) FEATURE:
        (D) OTHER INFORMATION: All C's are 2'-F modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 156:
GGGAGACAAG AAUAAACGCU CAACUCGGGA GCCAGAGUAA CAACGGCACU   50

AUAUAAUUUU ACUUCGACAG GAGGCUCACA ACAGGC   86

    (2) INFORMATION FOR SEQ ID NO: 157:
       (i) SEQUENCE CHARACTERIZATION:
          (A) LENGTH: 86 base pairs
          (B) TYPE: nucleic acid
          (C) STRANDEDNESS: single
          (D) TOPOLOGY: linear
       (ii) MOLECULAR TYPE: RNA
       (ix) FEATURE:
          (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
       (ix) FEATURE:
          (D) OTHER INFORMATION: All C's are 2'-F modified

       (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 157:
GGGAGACAAG AAUAAACGCU CAAAGAGCCG UUUUGGGGAC CCACAGUAAC   50
GGGUUUAUGG UAUUCGACAG GAGGCUCACA ACAGGC   86

    (2) INFORMATION FOR SEQ ID NO: 158:
       (i) SEQUENCE CHARACTERIZATION:
          (A) LENGTH: 86 base pairs
          (B) TYPE: nucleic acid
          (C) STRANDEDNESS: single
          (D) TOPOLOGY: linear
       (ii) MOLECULAR TYPE: RNA
       (ix) FEATURE:
          (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
       (ix) FEATURE:
          (D) OTHER INFORMATION: All C's are 2'-F modified

       (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 158:
GGGAGACAAG AAUAAACGCU CAAGUCGGAG CGAUGGAGAG CCACGAUAUA   50
CGGUCUGUGC GCUUCGACAG GAGGCUCACA ACAGGC   86

    (2) INFORMATION FOR SEQ ID NO: 159:
       (i) SEQUENCE CHARACTERIZATION:
          (A) LENGTH: 82 base pairs
          (B) TYPE: nucleic acid
          (C) STRANDEDNESS: single
          (D) TOPOLOGY: linear
       (ii) MOLECULAR TYPE: RNA
       (ix) FEATURE:
          (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
       (ix) FEATURE:
          (D) OTHER INFORMATION: All C's are 2'-F modified

       (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 159:
GGGAGACAAG AAUAAACGCU CAAAGUAACG UGGGGAGCCA CACGUAAUAC   50
GGCACUAAUU CGACAGGAGG CUCACAACAG GC   82

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(2) INFORMATION FOR SEQ ID NO: 160:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
   (ix) FEATURE:
    (D) OTHER INFORMATION: All C's are 2'-F modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 160:
GGGAGACAAG AAUAAACGCU CAAGGUACGA CCAAGGAAUG UGGGUGGAAG   50
AGGGCGCCGU ACCUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 161:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
   (ix) FEATURE:
    (D) OTHER INFORMATION: All C's are 2'-F modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 161:
GGGAGACAAG AAUAAACGCU CAAGAUCCUG CGACGCCAGG GGUGGAUAGG   50
GGGAAGGGAG CGGUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 162:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 87 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
    (D) OTHER INFORMATION: All U's are 2'-NH$_2$ modified
   (ix) FEATURE:
    (D) OTHER INFORMATION: All C's are 2'-F modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 162:
GGGAGACAAG AAUAAACGCU CAAGACGAAC GACCAAGGGA CGGGUGGGCA   50
AAUAGGGAUG CCGUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 163:
   (i) SEQUENCE CHARACTERIZATION:

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            (A)  LENGTH:  87 base pairs
            (B)  TYPE:  nucleic acid
            (C)  STRANDEDNESS:  single
            (D)  TOPOLOGY:  linear
        (ii)  MOLECULAR TYPE:  RNA
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All C's are 2'-F modified


        (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 163:
    GGGAGACAAG AAUAAACGCU CAAGGUACGA CCAAGGAAUG UGGGUGGAAG        50
    AGGGUGCCGU ACCUUCGACA GGAGGCUCAC AACAGGC                     87


    (2)  INFORMATION FOR SEQ ID NO: 164:
        (i)  SEQUENCE CHARACTERIZATION:
            (A)  LENGTH:  87 base pairs
            (B)  TYPE:  nucleic acid
            (C)  STRANDEDNESS:  single
            (D)  TOPOLOGY:  linear
        (ii)  MOLECULAR TYPE:  RNA
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All C's are 2'-F modified


        (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 164:
    GGGAGACAAG AAUAAACGCU CAACAACGCU GACCAUGGGA GGAAUGUGGG        50
    AAGGGCGCCA GCGUUCGACA GGAGGCUCAC AACAGGC                     87


    (2)  INFORMATION FOR SEQ ID NO: 165:
        (i)  SEQUENCE CHARACTERIZATION:
            (A)  LENGTH:  87 base pairs
            (B)  TYPE:  nucleic acid
            (C)  STRANDEDNESS:  single
            (D)  TOPOLOGY:  linear
        (ii)  MOLECULAR TYPE:  RNA
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
        (ix)  FEATURE:
            (D)  OTHER INFORMATION:  All C's are 2'-F modified


        (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 165:
    GGGAGACAAG AAUAAACGCU CAACAGCCAA GGGUUGGAUA GGGGGUAGGG        50
    AGCCGUAGCA GCGUUCGACA GGAGGCUCAC AACAGGC                     87


    (2)  INFORMATION FOR SEQ ID NO: 166:
        (i)  SEQUENCE CHARACTERIZATION:
            (A)  LENGTH:  87 base pairs
            (B)  TYPE:  nucleic acid
```

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```
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH2.modified
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 166:
GGGAGACAAG AAUAAACGCU CAACCGCCUG CGAUAGUUAG ACCGUUGAGC          50
UGAGAGCAAC ACUUUCGACA GGAGGCUCAC AACAGGC                        87


   (2)  INFORMATION FOR SEQ ID NO: 167:
      (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  86 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH2 modified
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 167:
GGGAGACAAG AAUAAACGCU CAAAAGGUGG GUUGAGGAGG AAAGUAGCGU          50
GAGUCAGUAC CAUUCGACAG GAGGCUCACA ACAGGC                         86


   (2)  INFORMATION FOR SEQ ID NO: 168:
      (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH2 modified
   (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 168:
GGGAGACAAG AAUAAACGCU CAAAGGGAGG AUUGUGGAGG AAGGGAGUGG          50
AAGUGUCCCA GCCUUCGACA GGAGGCUCAC AACAGGC                        87


   (2)  INFORMATION FOR SEQ ID NO: 169:
      (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
```

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```
 (ii)   MOLECULAR TYPE:  RNA
 (ix)   FEATURE:
   (D)   OTHER INFORMATION:   All U's are 2'-NH₂ modified
 (ix)   FEATURE:
   (D)   OTHER INFORMATION:   All C's are 2'-F modified


 (xi)   SEQUENCE DESCRIPTION:   SEQ ID NO: 169:
GGGAGACAAG AAUAAACGCU CAAGGAUGAC CAAGCGUCGA ACGAGGGAGG        50
AUUGUGGUGG AGGUUCGACA GGAGGCUCAC AACAGGC                      87


 (2)   INFORMATION FOR SEQ ID NO: 170:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH:   87 base pairs
    (B)   TYPE:   nucleic acid
    (C)   STRANDEDNESS:   single
    (D)   TOPOLOGY:   linear
  (ii)   MOLECULAR TYPE:  RNA
  (ix)   FEATURE:
    (D)   OTHER INFORMATION:   All U's are 2'-NH₂ modified
  (ix)   FEATURE:
    (D)   OTHER INFORMATION:   All C's are 2'-F modified


  (xi)   SEQUENCE DESCRIPTION:   SEQ ID NO: 170:
GGGAGACAAG AAUAAACGCU CAAGGGUGGA UUGUGGAGGA AGUAGCGCAG        50
GGUUCCGUAA GCCUUCGACA GGAGGCUCAC AACAGGC                      87


 (2)   INFORMATION FOR SEQ ID NO: 171:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH:   87 base pairs
    (B)   TYPE:   nucleic acid
    (C)   STRANDEDNESS:   single
    (D)   TOPOLOGY:   linear
  (ii)   MOLECULAR TYPE:  RNA
  (ix)   FEATURE:
    (D)   OTHER INFORMATION:   All U's are 2'-NH₂ modified
  (ix)   FEATURE:
    (D)   OTHER INFORMATION:   All C's are 2'-F modified


  (xi)   SEQUENCE DESCRIPTION:   SEQ ID NO: 171:
GGGAGACAAG AAUAAACGCU CAAAGGAGCG CCAUGAAGCA AAGGGAGGAU        50
UGUGGUGGAA GGCUUCGACA GGAGGCUCAC AACAGGC                      87

 (2)   INFORMATION FOR SEQ ID NO: 172:
   (i)   SEQUENCE CHARACTERIZATION:
    (A)   LENGTH:   86 base pairs
    (B)   TYPE:   nucleic acid
    (C)   STRANDEDNESS:   single
    (D)   TOPOLOGY:   linear
  (ii)   MOLECULAR TYPE:  RNA
  (ix)   FEATURE:
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```
    (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
 (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All C's are 2'-F modified
```

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 172: .
GGGAGACAAG AAUAAACGCU CAAACUGGAG CCAUACAGAC GAGAGGAUGG   50
GUGUGUGGAG GAUUCGACAG GAGGCUCACA ACAGGC   86

```
(2)  INFORMATION FOR SEQ ID NO: 173:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified
```

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 173:
GGGAGACAAG AAUAAACGCU CAAAGGGAGG AUUGUGGAGG AAGGGAGUGG   50
AAGUGUCUCA GCCUUCGACA GGAGGCUCAC AACAGGC   87

```
(2)  INFORMATION FOR SEQ ID NO: 174:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified
```

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 174:
GGGAGACAAG AAUAAACGCU CAAUCGGGUG AGGACUGGUA GAAAAAGGAG   50
GGUUGUGGAG GAGUUCGACA GGAGGCUCAC AACAGGC   87

```
(2)  INFORMATION FOR SEQ ID NO: 175:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
    (ix)  FEATURE:
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    (D)   OTHER INFORMATION: All C's are 2'-F modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 175:
GGGAGACAAG AAUAAACGCU CAAACCUGAU AACCGCGGAG GGAGGAUAGA   50
GGAGGAAGUG CGGUUCGACA GGAGGCUCAC AACAGGC   87

 (2)   INFORMATION FOR SEQ ID NO: 176:
    (i)   SEQUENCE CHARACTERIZATION:
     (A)   LENGTH: 86 base pairs
     (B)   TYPE: nucleic acid
     (C)   STRANDEDNESS: single
     (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
     (D)   OTHER INFORMATION: All U's are 2'-NH_2 modified
   (ix) FEATURE:
     (D)   OTHER INFORMATION: All C's are 2'-F modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 176:
GGGAGACAAG AAUAAACGCU CAAAGGCAGC CCCUCGACGA GAAAGGUGGG   50
UAGUGGAGGA ACUUCGACAG GAGGCUCACA ACAGGC   86

 (2)   INFORMATION FOR SEQ ID NO: 177:
    (i)   SEQUENCE CHARACTERIZATION:
     (A)   LENGTH: 87 base pairs
     (B)   TYPE: nucleic acid
     (C)   STRANDEDNESS: single
     (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
     (D)   OTHER INFORMATION: All U's are 2'-NH_2 modified
   (ix) FEATURE:
     (D)   OTHER INFORMATION: All C's are 2'-F modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 177:
GGGAGACAAG AAUAAACGCU CAACUUACGA CACCAAAGGG AGGAUUGUGG   50
UGGAAUGGGG UCGUUCGACA GGAGGCUCAC AACAGGC   87

 (2)   INFORMATION FOR SEQ ID NO: 178:
    (i)   SEQUENCE CHARACTERIZATION:
     (A)   LENGTH: 38 base pairs
     (B)   TYPE: nucleic acid
     (C)   STRANDEDNESS: single
     (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
     (D)   OTHER INFORMATION: All pyrimidines are 2'-F
           modified

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 178:

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GGGAAACGGC UGUAACAAAC AAGGUGGGGG GCCACACA   38

(2) INFORMATION FOR SEQ ID NO: 179:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 56 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
     (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 179:
GGGAGACAAG AAUAAACGCU CAAGUCUGAC UAUUGGGGCG CCACAAUAUC   50
AACGGC   56

(2) INFORMATION FOR SEQ ID NO: 180:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 49 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
     (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 180:
AAGAAUAAAC GCUCAAGCUG CCCAAGGAAU UUAACUUGGA CCGCGAUCU   49

(2) INFORMATION FOR SEQ ID NO: 181:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 31 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: RNA
   (ix) FEATURE:
     (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 181:
AAGCAAAGGG AGGAUUGUGG UGGAAGGCUU C   31

(2) INFORMATION FOR SEQ ID NO: 182:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 51 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single

```
        (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
        (D)  OTHER INFORMATION:  All pyrimidines are 2'-NH₂
             modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 182:
GGGACGCUCA AGAGCUGGUG AGCCACGUAU ACGGCCUUAG GGGCUUGGGC          50
G                                                               51


(2)  INFORMATION FOR SEQ ID NO: 183:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  59 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
   (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All C's are 2'-F modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 183:
GGGAGACAAG AAUAAACGCU CAAAGAGUGC AGGUCUGGGG CGCCACAAUU          50
AGAACGGCA                                                       59


(2)  INFORMATION FOR SEQ ID NO: 184:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  27 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
   (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All C's are 2'-F modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 184:
GCUCAACCGC CUGCGAUAGU UAGACCG                                   27


(2)  INFORMATION FOR SEQ ID NO: 185:
   (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  47 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
    (D)  OTHER INFORMATION:  All U's are 2'-NH₂ modified
```

```
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All C's are 2'-F modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 185:
CCUGCGACGC CAGGGGUGGA UAGGGGGAAG GGAGCGGUUC GACAGGA          47


 (2)  INFORMATION FOR SEQ ID NO: 186:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  87 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 186:
GGGAGACAAG AAUAAACGCU CAANNNNNNN NNNNNNNNNN NNNNNNNNNN          50
NNNNNNNNNN NNNUUCGACA GGAGGCUCAC AACAGGC                      87


 (2)  INFORMATION FOR SEQ ID NO: 187:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  40 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 187:
TAATACGACT CACTATAGGG AGACAAGAAT AAACGCTCAA                   40


 (2)  INFORMATION FOR SEQ ID NO: 188:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  24 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 188:
GCCTGTTGTG AGCCTCCTGT CGAA                                    24


 (2)  INFORMATION FOR SEQ ID NO: 189:
    (i)  SEQUENCE CHARACTERIZATION:
      (A)  LENGTH:  84 base pairs
      (B)  TYPE:  nucleic acid
      (C)  STRANDEDNESS:  single
      (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified
```

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 189:

GGGAGACAAG AAUAAACGCU CAAACAUCGU AUAACUCUAA GGGCCUGGAU   50
AUACGAUGAA UUCGACAGGA GGCUCACAAC AGGC   84

(2) INFORMATION FOR SEQ ID NO: 190:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 84 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 190:

GGGAGACAAG AAUAAACGCU CAAACAUCGU AUAACUCUAA GCGCCUGGAU   50
AUACGAUGAA UUCGACAGGA GGCUCACAAC AGGC   84

(2) INFORMATION FOR SEQ ID NO: 191:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 84 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 191:

GGGAGACAAG AAUAAACGCU CAAACAUCGU AUAACUCUAA GAGCCUGGAU   50
AUACGAUGAA UUCGACAGGA GGCUCACAAC AGGC   84

(2) INFORMATION FOR SEQ ID NO: 192:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 84 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 192:

GGGAGACAAG AAUAAACGCU CAAACAUCGU AUAACUCUAA GUGCCUGGAU   50
AUACGAUGAA UUCGACAGGA GGCUCACAAC AGGC   84

(2) INFORMATION FOR SEQ ID NO: 193:

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```
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  85 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 193:
GGGAGACAAG AAUAAACGCU CAAACAUCGU AUAAUCUCUA AGAGCCUGGA          50
UAUACGAUGA AUUCGACAGG AGGCUCACAA CAGGC                         85


 (2)  INFORMATION FOR SEQ ID NO: 194:
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  86 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 194:
GGGAGACAAG AAUAAACGCU CAAACAUCGU AUAAUCUCUC UAAGAGCCUG          50
GAAUACGAUG AAUUCGACAG GAGGCUCACA ACAGGC                        86


 (2)  INFORMATION FOR SEQ ID NO: 195:
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  88 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
     (ii)  MOLECULAR TYPE:  RNA
     (ix)  FEATURE:
       (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
            modified


     (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 195:
GGGAGACAAG AAUAAACGCU CAAAUCCCAA UCUCUAAGAG CCUGGAUAAG          50
AAUGCGCAUU GGGCUUCGAC AGGAGGCUCA CAACAGGC                      88

 (2)  INFORMATION FOR SEQ ID NO: 196:
     (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  87 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
```

```
    (ii)  MOLECULAR TYPE:  RNA
    (ix)  FEATURE:
      (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
           modified


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 196:
GGGAGACAAG AAUAAACGCU CAAAUCCCAA UCUCUAAGAG CCUGGAUGAC     50
AAUCGCAUUG GGCUUCGACA GGAGGCUCAC AACAGGC                   87


(2)  INFORMATION FOR SEQ ID NO: 197:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  88 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 197:
GGGAGACAAG AAUAAACGCU CAAAUCCCAA UCUCUAAGAG CCUGGAUGAG     50
AAUGCGCAUU GGGCUUCGAC AGGAGGCUCA CAACAGGC                  88


(2)  INFORMATION FOR SEQ ID NO: 198:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  86 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified


   (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 198:
GGGAGACAAG AAUAAACGCU CAACUGAGAU CUCUAAGAGC CUGGACUCAG     50
CUCCGACUGA CCUUCGACAG GAGGCUCACA ACAGGC                    86


(2)  INFORMATION FOR SEQ ID NO: 199:
   (i)  SEQUENCE CHARACTERIZATION:
     (A)  LENGTH:  87 base pairs
     (B)  TYPE:  nucleic acid
     (C)  STRANDEDNESS:  single
     (D)  TOPOLOGY:  linear
   (ii)  MOLECULAR TYPE:  RNA
   (ix)  FEATURE:
     (D)  OTHER INFORMATION:  All pyrimidines are 2'-F
          modified
```

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(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 199:

GGGAGACAAG AAUAAACGCU CAACUGAGAU CUCUAAGAGC CUGGACUCAG   50
CUCCGAUUGA UCCUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 200:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 87 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 200:

GGGAGACAAG AAUAAACGCU CAACUGAGAU CUCUAAGAGC CUGGACUCAG   50
CUCCGAUUGA ACCUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 201:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 87 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 201:

GGGAGACAAG AAUAAACGCU CAAUCUCUAU GAGCCUGGAU CGACGAACUC   50
UCUACGGGCU GUGUUCGACA GGAGGCUCAC AACAGGC   87

(2) INFORMATION FOR SEQ ID NO: 202:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 86 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: RNA
    (ix) FEATURE:
      (D) OTHER INFORMATION: All pyrimidines are 2'-F
          modified

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 202:

GGGAGACAAG AAUAAACGCU CAAUCUCUAA GAGCCUGGAU GUCGAGGGGC   50
CAUUUCGCAC GCUUCGACAG GAGGCUCACA ACAGGC   86

(2) INFORMATION FOR SEQ ID NO: 203:

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```
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  88 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  RNA
   (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified
```

```
    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 203:
GGGAGACAAG AAUAAACGCU CAAAUCUCUA CUGAGCCUGG AUUCGCCAGA          50
AGUUUUAUCA CAGUUUCGAC AGGAGGCUCA CAACAGGC                       88
```

```
(2)   INFORMATION FOR SEQ ID NO: 204:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  87 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  RNA
   (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified
```

```
    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 204:
GGGAGACAAG AAUAAACGCU CAACGUAAAA GUUAUCGAAU CUCUGUGAGC          50
CUGGAUCGAU UACUUCGACA GGAGGCUCAC AACAGGC                        87
```

```
(2)   INFORMATION FOR SEQ ID NO: 205:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  97 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  RNA
   (ix)   FEATURE:
      (D)   OTHER INFORMATION:  All pyrimidines are 2'-F
            modified
```

```
    (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 205:
GGGAGACAAG AAUAAACGCU CAACUGAGAU CUCUAAGAGC CUGGACUCAG          50
CUACGAUUGA GCGUUUAUUC UUGUUCGACA GGAGGCUCAC AACAGGC             97
```

```
(2)   INFORMATION FOR SEQ ID NO: 206:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  77 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
```

    (ii) MOLECULAR TYPE: RNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 206:

```
GGGAGCUCAG AAUAAACGCU CAANNNNNNN NNNNNNNNNN NNNNNNNNNN     50
NNNUUCGACA UGAGGCCCGG AUCCGGC                             77
```


(2) INFORMATION FOR SEQ ID NO: 207:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 24 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 207:

```
GCCGGATCCG GGCCTCATGT CGAA                               24
```


(2) INFORMATION FOR SEQ ID NO: 208:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 48 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 208:

```
CCGAAGCTTA ATACGACTCA CTATAGGGAG CTCAGAATAA ACGCTCAA     48
```


(2) INFORMATION FOR SEQ ID NO: 209:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 77 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 209:

```
GGGAGCTCAG AATAAACGCT CAAACGGCTG ACAACGGCTG GACTTGCGTA     50
TTGTTCGACA TGAGGCCCGG ATCCGGC                             77
```


(2) INFORMATION FOR SEQ ID NO: 210:
    (i) SEQUENCE CHARACTERIZATION:
      (A) LENGTH: 77 base pairs
      (B) TYPE: nucleic acid
      (C) STRANDEDNESS: single
      (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 210:

```
GGGAGCTCAG AATAAACGCT CAAGCGCTTG ACCATTTCGT AGGGTCGCCC     50
```

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TTGTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 211:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 211:
GGGAGCTCAG AATAAACGCT CAAGATCGAC GCATCGAGTC GCCTCATCGC   50
TCCTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 212:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 212:
GGGAGCTCAG AATAAACGCT CAACGCACTC GGACGGAATC TCCGTAGGAC   50
ACGTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 213:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 213:
GGGAGCTCAG AATAAACGCT CAATGTCATG CATGTGTGTC GCCTCATCAC   50
GCATTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 214:
   (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 214:
GGGAGCTCAG AATAAACGCT CAACCACTGG CTAGGAACTC GAGTACTGGG   50
TGGTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 215:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: DNA

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 215:
GGGAGCTCAG AATAAACGCT CAATTCGAAG CCACGTTTCA TGTCCGTCGC   50
TGCTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 216:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: DNA

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 216:
GGGAGCTCAG AATAAACGCT CAACAGTGGA GGCTGTCCAA ACCCACCCAC   50
CCCTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 217:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 76 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: DNA

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 217:
GGGAGCTCAG AATAAACGCT CAAGTGGAGG GTACGTGGAG GGGAGAGCGA   50
TATTCGACAT GAGGCCCGGA TCCGGC   76

(2)   INFORMATION FOR SEQ ID NO: 218:
    (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 76 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
    (ii)   MOLECULAR TYPE: DNA

    (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 218:
GGGAGCTCAG AATAAACGCT CAATCTCATG CTCGCGTGCG TCGCCTCAAC   50
CATTCGACAT GAGGCCCGGA TCCGGC   76

(2)   INFORMATION FOR SEQ ID NO: 219:
    (i)   SEQUENCE CHARACTERIZATION:

```
       (A)  LENGTH:  77 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 219:
GGGAGCTCAG AATAAACGCT CAATCCCTCA GTGTCAAGTG CGTCGCCTCA          50
GCATTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)  INFORMATION FOR SEQ ID NO: 220:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  78 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 220:
GGGAGCTCAG AATAAACGCT CAACTTCTTG GCCCCGTCTC AATGTCCGTA          50
CTTCTTCGAC ATGAGGCCCG GATCCGGC                                  78


(2)  INFORMATION FOR SEQ ID NO: 221:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  77 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 221:
GGGAGCTCAG AATAAACGCT CAACGTGATT TGGCCACGGG AAAGAGCCAT          50
ACCTTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)  INFORMATION FOR SEQ ID NO: 222:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  77 base pairs
       (B)  TYPE:  nucleic acid
       (C)  STRANDEDNESS:  single
       (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 222:
GGGAGCTCAG AATAAACGCT CAACGTTGAA CGCTTGGTTT CATGTCCCTC          50
GCCTTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)  INFORMATION FOR SEQ ID NO: 223:
    (i)  SEQUENCE CHARACTERIZATION:
       (A)  LENGTH:  77 base pairs
       (B)  TYPE:  nucleic acid
```

```
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 223: .
GGGAGCTCAG AATAAACGCT CAACGTCGAT CGCGTGCTGT AGCCTCAGGC        50
ACCTTCGACA TGAGGCCCGG ATCCGGC                                 77


(2)  INFORMATION FOR SEQ ID NO: 224:
    (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH:  78 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 224:
GGGAGCTCAG AATAAACGCT CAAGGTGGAA GGCCTTTGAA GCCCGTACAT        50
CTCCTTCGAC ATGAGGCCCG GATCCGGC                                78


(2)  INFORMATION FOR SEQ ID NO: 225:
    (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH:  77 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 225:
GGGAGCTCAG AATAAACGCT CAAGGTCGAA CTAGCGCTGG AGCGTGCGTT        50
GGTTTCGACA TGAGGCCCGG ATCCGGC                                 77


(2)  INFORMATION FOR SEQ ID NO: 226:
    (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH:  77 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
    (ii)  MOLECULAR TYPE:  DNA


    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 226:
GGGAGCTCAG AATAAACGCT CAAGTCGCTC GATCGTTTCA TGCCCGTCCG        50
ACCTTCGACA TGAGGCCCGG ATCCGGC                                 77


(2)  INFORMATION FOR SEQ ID NO: 227:
    (i)  SEQUENCE CHARACTERIZATION:
        (A)  LENGTH:  77 base pairs
        (B)  TYPE:  nucleic acid
        (C)  STRANDEDNESS:  single
        (D)  TOPOLOGY:  linear
```

(ii) MOLECULAR TYPE: DNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 227:
GGGAGCTCAG AATAAACGCT CAAGTCGATG CGCAGTCCGC CTCAGCTGCA   50
CTGTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 228:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 77 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 228:
GGGAGCTCAG AATAAACGCT CAAGGTGTGC CCAAGGCCCT TGAGAGAGGC   50
GTGTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 229:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 77 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 229:
GGGAGCTCAG AATAAACGCT CAACGTCTAG GAACTGCGTC GCCTCAACAG   50
CGCTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 230:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 72 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 230:
GGGAGCTCAG AATAAACGCT CAAGTCGGAT GGTTTTGCGC GTTTCCCGTT   50
CGACATGAGG CCCGGATCCG GC   72

(2) INFORMATION FOR SEQ ID NO: 231:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 77 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

```
    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 231:
GGGAGCTCAG AATAAACGCT CAACCTCATC CTCGCACGCC ATCGCCTGAA      50
CCGTTCGACA TGAGGCCCGG ATCCGGC                               77
```

(2)   INFORMATION FOR SEQ ID NO: 232:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA


```
    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 232:
GGGAGCTCAG AATAAACGCT CAAGGTGTGC CAAAGGCCCT TGAGAGAGGC      50
GTATTCGACA TGAGGCCCGG ATCCGGC                               77
```

(2)   INFORMATION FOR SEQ ID NO: 233:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA


```
    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 233:
GGGAGCTCAG AATAAACGCT CAAGGCCGCA TGCCCCTCCT AACAGCATGC      50
AACTTCGACA TGAGGCCCGG ATCCGGC                               77
```

(2)   INFORMATION FOR SEQ ID NO: 234:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA


```
    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 234:
GGGAGCTCAG AATAAACGCT CAACCCTCGT GCGTGCGCTT GGAGCGTGGC      50
GCATTCGACA TGAGGCCCGG ATCCGGC                               77
```

(2)   INFORMATION FOR SEQ ID NO: 235:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA


```
    (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 235:
GGGAGCTCAG AATAAACGCT CAAGTCGCTC GATCGTTTCA TGTCCGTTCG      50
```

ACCTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 236:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 74 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 236:
GGGAGCTCAG AATAAACGCT CAAGTCCACA CTTTGCCGAG CGTCCTAGTG   50
TTCGACATGA GGCCCGGATC CGGC   74

(2) INFORMATION FOR SEQ ID NO: 237:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 76 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 237:
GGGAGCTCAG AATAAACGCT CAACGGGTGA ATCACGGCTG GTGCGTTGCC   50
CCTTCGACAT GAGGCCCGGA TCCGGC   76

(2) INFORMATION FOR SEQ ID NO: 238:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 77 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 238:
GGGAGCTCAG AATAAACGCT CAACGTCGAC GCACTGTGCC GCCTCACACA   50
CGCTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 239:
   (i) SEQUENCE CHARACTERIZATION:
     (A) LENGTH: 77 base pairs
     (B) TYPE: nucleic acid
     (C) STRANDEDNESS: single
     (D) TOPOLOGY: linear
   (ii) MOLECULAR TYPE: DNA

   (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 239:
GGGAGCTCAG AATAAACGCT CAAGCGAACG TCATGCCGCC TCATCATGCC   50
ACGTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 240:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 76 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: DNA

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 240:
GGGAGCTCAG AATAAACGCT CAACTAGGCC CACCGTCCCT TCTAACAACG   50
TCTTCGACAT GAGGCCCGGA TCCGGC   76

(2)   INFORMATION FOR SEQ ID NO: 241:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: DNA

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 241:
GGGAGCTCAG AATAAACGCT CAACAGTCAC GAACGTGCGC CGGAAGAACG   50
CTCTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 242:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: DNA

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 242:
GGGAGCTCAG AATAAACGCT CAATGTCGCA CGTGTCCCGG CCCGCCCTAC   50
CCCTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 243:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH: 77 base pairs
      (B)   TYPE: nucleic acid
      (C)   STRANDEDNESS: single
      (D)   TOPOLOGY: linear
   (ii)   MOLECULAR TYPE: DNA

   (xi)   SEQUENCE DESCRIPTION: SEQ ID NO: 243:
GGGAGCTCAG AATAAACGCT CAACAGGTGG CACCGCCCTT CCAACACGGT   50
GCGTTCGACA TGAGGCCCGG ATCCGGC   77

(2)   INFORMATION FOR SEQ ID NO: 244:
   (i)   SEQUENCE CHARACTERIZATION:

```
    (A)  LENGTH:  74 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii) MOLECULAR TYPE:  DNA


  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 244:
GGGAGCTCAG AATAAACGCT CAAGTCCACA CTTTGCCGAG CGTCCTAGTG     50
TTCGACATGA GGCCCGGATC CGGC                                74


(2)  INFORMATION FOR SEQ ID NO: 245:
  (i).  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  77 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii) MOLECULAR TYPE:  DNA


  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 245:
GGGAGCTCAG AATAAACGCT CAAATGGTGG AGGCCATCTC AAACCCACGA     50
CACTTCGACA TGAGGCCCGG ATCCGGC                             77


(2)  INFORMATION FOR SEQ ID NO: 246:
  (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  77 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii) MOLECULAR TYPE:  DNA


  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 246:
GGGAGCTCAG AATAAACGCT CAACGCCGAG ACCCACCTCA TAACACCGCT     50
ACCTTCGACA TGAGGCCCGG ATCCGGC                             77


(2)  INFORMATION FOR SEQ ID NO: 247:
  (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  77 base pairs
    (B)  TYPE:  nucleic acid
    (C)  STRANDEDNESS:  single
    (D)  TOPOLOGY:  linear
  (ii) MOLECULAR TYPE:  DNA


  (xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 247:
GGGAGCTCAG AATAAACGCT CAATGAGGCG CGCCACAGGA TGGCCCTCAA     50
CCCTTCGACA TGAGGCCCGG ATCCGGC                             77


(2)  INFORMATION FOR SEQ ID NO: 248:
  (i)  SEQUENCE CHARACTERIZATION:
    (A)  LENGTH:  77 base pairs
    (B)  TYPE:  nucleic acid
```

```
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  DNA


   (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 248: .
GGGAGCTCAG AATAAACGCT CAAGTCCGCA TGATGCTTCG AACAGCATAC          50
AACTTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)   INFORMATION FOR SEQ ID NO: 249:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  77 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  DNA


   (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 249:
GGGAGCTCAG AATAAACGCT CAAGGTGTGC CCCTACGTGC GGCCCTTCGT          50
TTATTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)   INFORMATION FOR SEQ ID NO: 250:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  77 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  DNA


   (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 250:
GGGAGCTCAG AATAAACGCT CAACGGCTTG CAGGTCGCCG AAATGACCGC          50
ACATTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)   INFORMATION FOR SEQ ID NO: 251:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  77 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
   (ii)   MOLECULAR TYPE:  DNA


   (xi)   SEQUENCE DESCRIPTION:  SEQ ID NO: 251:
GGGAGCTCAG AATAAACGCT CAACTAGTTC AACCGTCCCT TCTAACAACC          50
GTCTTCGACA TGAGGCCCGG ATCCGGC                                   77


(2)   INFORMATION FOR SEQ ID NO: 252:
   (i)   SEQUENCE CHARACTERIZATION:
      (A)   LENGTH:  77 base pairs
      (B)   TYPE:  nucleic acid
      (C)   STRANDEDNESS:  single
      (D)   TOPOLOGY:  linear
```

      (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 252:
GGGAGCTCAG AATAAACGCT CAACCTGGTG GTCGTGCGGC TGTCGCCTCA   50
AGGTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 253:
    (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 253:
GGGAGCTCAG AATAAACGCT CAAGATCGAA GTTGTCGTCC GCCTCAGCGA   50
CTCTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 254:
    (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 254:
GGGAGCTCAG AATAAACGCT CAATGTCGAG TGCGATGGAG GAGTAGGGAT   50
GCATTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 255:
    (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 77 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

    (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 255:
GGGAGCTCAG AATAAACGCT CAATGTCGAT CGTGTCAAGG TCCGTCCTAC   50
TTCTTCGACA TGAGGCCCGG ATCCGGC   77

(2) INFORMATION FOR SEQ ID NO: 256:
    (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 71 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
    (ii) MOLECULAR TYPE: DNA

```
(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 256:
GGGAGGACGA TGCGGNNNNN NNNNNNNNNN NNNNNNNNNN NNNNNNNNNN          50
NNNNNCAGAC GACTCGCCCG A                                        71
```

(2) INFORMATION FOR SEQ ID NO: 257:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 15 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: DNA

```
(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 257:
GGGAGGACGA TGCGG                                               15
```

(2) INFORMATION FOR SEQ ID NO: 258:
  (i) SEQUENCE CHARACTERIZATION:
    (A) LENGTH: 20 base pairs
    (B) TYPE: nucleic acid
    (C) STRANDEDNESS: single
    (D) TOPOLOGY: linear
  (ii) MOLECULAR TYPE: DNA
  (ix) FEATURE:
    (D) OTHER INFORMATION: N at positions 1-4 is biotin

```
(xi)  SEQUENCE DESCRIPTION:  SEQ ID NO: 258:
NNNNTCGGGC GAGTCGTCTG                                          20
```

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WE CLAIM:

1. A method of identifying nucleic acid ligands to a cytokine, comprising:

a) contacting a candidate mixture of nucleic acids with said cytokine, wherein nucleic acids having an increased affinity to said cytokine relative to the candidate mixture may be partitioned from the remainder of the candidate mixture; and

b) partitioning the increased affinity nucleic acids from the remainder of the candidate mixture; and

c) amplifying the increased affinity nucleic acids to yield a mixture of nucleic acids enriched for nucleic acid sequences with relatively higher affinity and specificity for binding to said cytokine, whereby nucleic acid ligands of said cytokine may be identified.

2. The method of claim 1 further comprising:

d) repeating steps a), b), and c).

3. The method of claim 1 wherein said candidate mixture of nucleic acids is comprised of single stranded nucleic acids.

4. The method of claim 3 wherein said single stranded nucleic acids are ribonucleic acids.

5. The method of claim 4 wherein said nucleic acids are modified nucleic acids.

6. The method of claim 5 wherein said nucleic acids are 2'-amino (2'-NH_2) modified ribonucleic acids.

7. The method of claim 5 wherein said nucleic acids are 2'-fluoro (2'-F) modified ribonucleic acids.

8. The method of claim 3 wherein said single stranded nucleic acids are deoxyribonucleic acids.

9. The method of claim 1 wherein said cytokine is selected from the group consisting of IFN-gamma, IL-10, IL-4, TNF-alpha, and RANTES.

10. The method of claim 1 wherein said cytokine is IFN-gamma.

11. The method of claim 1 wherein said cytokine is IL-10.

12. The method of claim 1 wherein said cytokine is IL-4.

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13. The method of claim 1 wherein said cytokine is TNF-alpha.

14. The method of claim 1 wherein said cytokine is RANTES.

15. A method for treating a cytokine-mediated disease comprising administering a pharmaceutically effective amount of a nucleic acid ligand of a cytokine.

16. The method of claim 15 wherein said nucleic acid ligand of a cytokine is identified according to the method of claim 1.

17. The method of claim 16 wherein said cytokine is IFN-gamma.

18. The method of claim 17 wherein said ligand is selected from one of the ligands of Tables 3 and 4 (SEQ ID NOS:7-73).

19. The method of claim 16 wherein said cytokine is IL-4.

20. The method of claim 17 wherein said ligand is selected from one of the ligands of Tables 7 and 8 (SEQ ID NOS:100-185).

21. The method of claim 16 wherein said cytokine is IL-10.

22. The method of claim 21 wherein said ligand is selected from one of the ligands of Table 10 (SEQ ID NOS:189-205).

23. The method of claim 16 wherein said cytokine is TNF-alpha.

24. The method of claim 23 wherein said ligand is selected from one of the ligands of Table 12 (SEQ ID NOS:209-255).

25. A purified and isolated non-naturally occurring nucleic acid ligand to a cytokine.

26. The purified and isolated non-naturally occurring nucleic acid ligand of claim 25 wherein said nucleic acid ligand is single-stranded.

27. The purified and isolated non-naturally occurring nucleic acid ligand of claim 26 wherein said nucleic acid ligand is ribonucleic acid.

28. The purified and isolated non-naturally occurring nucleic acid ligand of claim 26 wherein said nucleic acid ligand is deoxyribonucleic acid.

29. A nucleic acid ligand to a cytokine identified according to the method comprising:

a) contacting a candidate mixture of nucleic acids with said cytokine, wherein nucleic acids having an increased affinity to said cytokine relative to the candidate mixture may be partitioned from the remainder of the candidate mixture; and

b) partitioning the increased affinity nucleic acids from the remainder of the candidate mixture; and

c) amplifying the increased affinity nucleic acids to yield a mixture of nucleic acids enriched for nucleic acid sequences with relatively higher affinity and specificity for binding to said cytokine, whereby nucleic acid ligands of said cytokine may be identified.

30. The purified and isolated non-naturally occurring ribonucleic acid ligand of claim 27, wherein said ligand is IFN-gamma.

31. The purified and isolated non-naturally occurring ribonucleic acid ligand to IFN-gamma of claim 30 wherein said ligand is selected from the group consisting of the sequences set forth in Tables 3 and 4 (SEQ ID NOS:7-73).

32. The purified and isolated non-naturally occurring ribonucleic acid ligand to IFN-gamma of claim 30 wherein said ligand is substantially homologous to and has substantially the same ability to bind IFN-gamma as a ligand selected from the group consisting of the sequences set forth in Tables 3 and 4 (SEQ ID NOS:7-73).

33. The purified and isolated non-naturally occurring ribonucleic acid ligand to IFN-gamma of claim 30 wherein said ligand has substantially the same structure and substantially the same ability to bind IFN-gamma as a ligand selected from the group consisting of the sequences set forth in Tables 3 and 4 (SEQ ID NOS:7-73).

34. The purified and isolated non-naturally occurring ribonucleic acid ligand of claim 27 wherein said ligand is to IL-4.

35. The purified and isolated non-naturally occurring ribonucleic acid ligand to IL-4 of claim 34 wherein said ligand is selected from the group consisting of the sequences set forth in Tables 7 and 8 (SEQ ID NOS:79-185).

36. The purified and isolated non-naturally occurring ribonucleic acid ligand to IL-4 of claim 34 wherein said ligand is substantially homologous to and has substantially the

same ability to bind IL-4 as a ligand selected from the group consisting of the sequences set forth in Tables 7 and 8 (SEQ ID NOS:79-185).

37. The purified and isolated non-naturally occurring ribonucleic acid ligand to IL-4 of claim 34 wherein said ligand has substantially the same structure and substantially the same ability to bind IL-4 as a ligand selected from the group consisting of the sequences set forth in Tables 7 and 8 (SEQ ID NOS:79-185).

38. The purified and isolated non-naturally occurring ribonucleic acid ligand of claim 27 wherein said ligand is to IL-10.

39. The purified and isolated non-naturally occurring ribonucleic acid ligand to IL-10 of claim 38 wherein said ligand is selected from the group consisting of the sequences set forth in Table 10 (SEQ ID NOS:189-205).

40. The purified and isolated non-naturally occurring ribonucleic acid ligand to IL-10 of claim 38 wherein said ligand is substantially homologous to and has substantially the same ability to bind IL-10 as a ligand selected from the group consisting of the sequences set foreth in Table 10 (SEQ ID NOS:189-205).

41. The purified and isolated non-naturally occurring ribonucleic acid ligand to IL-10 of claim 38 wherein said ligand has substantially the same structure and substantially the same ability to bind IL-10 as a ligand selected from the group consisting of the sequences set forth in Table 10 (SEQ ID NOS:189-205).

42. The purified and isolated non-naturally occurring ribonucleic acid ligand of claim 27 wherein said ligand is to TNF-alpha.

43. The purified and isolated non-naturally occurring ribonucleic acid ligand to TNF-alpha of claim 42 wherein said ligand is selected from the group consisting of the sequences set forth in Table 12 (SEQ ID NOS:209-255).

44. The purified and isolated non-naturally occurring ribonucleic acid ligand to TNF-alpha of claim 42 wherein said ligand is substantially homologous to and has substantially the same ability to bind TNF-alpha as a ligand selected from the group consisting of the sequences set forth in Table 12 (SEQ ID NOS:209-255).

45. The purified and isolated non-naturally occurring ribonucleic acid ligand to TNF-alpha of claim 42 wherein said ligand has substantially the same structure and

substantially the same ability to bind TNF-alpha as a ligand selected from the group consisting of the sequences set forth in Table 12 (SEQ ID NOS:189-205).

46. The purified and isolated non-naturally occurring nucleic acid ligand of claim 25 wherein said ligand is to RANTES.

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6)   :C07H 21/02, 21/04; C12P 19/34; C12Q 1/68
US CL   :435/6, 91.2; 536/22.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S.   :   435/6, 91.2; 536/22.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,270,163 A (GOLD ET AL.) 14 December 1993, column 5, column 46, Example 6.	1-17, 19, 21, 23, 25-30, 34, 38, 42, 46
Y	WO 92/14843 A1 (GILEAD SCIENCES, INC.) 03 September 1992, pages 12-15.	1-17, 19, 21, 23, 25-30, 34, 38, 42, 46

☐ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier document published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed

"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 AUGUST 1996	0 5 SEP 1996

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	STEPHANIE W. ZITOMER, Ph.D.
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0196

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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 18, 20, 22, 24, 31-33, 35-37, 39-41, 43-45
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

   These claims were not searched because they are drawn to nucleotide sequences identified by their SEQ ID NO:s and the required Sequence Listing/CRF has not been submitted nor is it in the prior US applications.

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest   ☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

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